Section 5 – Risk Assessment

This section of the plan addresses requirements of Interim Final Rule (IFR) Section 201.4 (c) (2). A copy of the IFR is provided for reference in **Appendix B** of this document.

Contents of this Section

Section	What has been updated?
5.1	• IFR language pertaining to plan updates was added.
5.2	• Incorporated information from local plan review regarding hazard identification and profile. • Divided hurricanes into two separate hazards, floods (includes storm surge) and high wind (includes hurricane winds and tornados) • Added tsunamis to the list of hazards to be profiled. • Incorporated new hazard information and recent hazard events.
5.3	• The list of hazards evaluated for further analysis was revised to reflect the list identified and profiled in the updated Section 5.2. • Earthquakes received a high rating based on new data and a better understanding of the State's risk to them
5.4	• No substantial revisions.
5.5	• This sub-section was generally restructured. • A discussion of general statewide risk to natural hazards was added which includes information from local hazard mitigation plan loss estimates as well as Project Worksheet information from recent disasters. • Initial plan included a survey of state agencies as a methodology to characterize risk to state facilities; this discussion was removed because the methodology proved unsuccessful. • The statewide risk assessment for flood was revised to reflect new NFIP Claims and Repetitive Loss data. • The statewide risk assessment for wind was restructured to reflect the combination of tornados and hurricane winds into a single hazard; the team used one methodology to assess vulnerability to tornados and one methodology to assess vulnerability to hurricane winds. • The tornado risk assessment focuses on updated NCDC records. • The hurricane risk assessment focuses on wind damages as predicted by HAZUS. • The earthquake risk assessment focuses on damages as predicted by HAZUS.
5.6	• This section was updated based on new risk data and analysis results.
5.7	• This section was added to summarize the impacts of population growth, economic development, and transportation improvements on jurisdictions' vulnerability.

5.1 Interim Final Rule Requirements for Risk Assessments

The Interim Final Rule (IFR) Subsection (201.4 (c) (2)) requires that the plan include:

"Risk Assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments. The risk assessment shall include the following

(i) An overview of the type and location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate.

(ii) An overview and analysis of the State's vulnerability to the hazards described in paragraph (c) (2), based on estimates provides in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed.

(iii) An overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure and critical facilities located in the identified hazard areas."

The IFR Subsection (201.4 (d)) states:

> "*Review and Updates. Plan must be reviewed and revised to reflect changes in development…"*

5.2 Overview of Type and Location of All Natural Hazards That Can Affect the State

In the initial phase of the planning process, the State Hazard Mitigation Team (SHMT) considered 15 natural hazards and the risks they create for the citizens of the Alabama. These hazards were initially selected for inclusion in the plan by AEMA, and the list was later reviewed and approved by the SHMT in its general meeting on April 8, 2004 in Montgomery, Alabama. The hazards initially considered were:

1. Floods;
2. Tornados and windstorms;
3. Hurricanes;
4. Earthquakes;
5. Winter/ice storms;
6. Landslides;
7. Land subsidence;

8. Drought;
9. Hail;
10. Wildfires;
11. Extreme temperatures;
12. Lightning;
13. Dam failure;
14. Hazardous materials; and
15. Manmade hazards.

This list was approved by both the SHMT and FEMA in 2004.

During the 2007 plan update process, it was determined that instead of identifying hurricanes as a single hazard, it would be divided into two separate hazards that are associated with hurricanes: flooding (both by rainfall and by storm surge) and high winds. Tornados and windstorms are also included in the high wind profile section and risk assessment. All information from the hurricane profile section of the 2004 Plan is now included as part of the profiles for flooding and high winds. At the request of both AEMA and the National Weather Service, tsunamis were added to the list of hazards to be profiled. In addition, it was determined that hazardous materials and manmade hazards would not be considered a part of the scope of this update and they were removed from the plan. This was done with SHMT and FEMA concurrence in April 2004. The hazards profiled in this section are:

1. Floods (Storm surge, riverine, flash floods, etc.);
2. High Winds (Hurricanes, tornados and windstorms);
3. Winter/ice storms;
4. Landslides;
5. Land subsidence;
6. Earthquakes;
7. Drought;
8. Hail;
9. Wildfires;
10. Extreme temperatures;
11. Lightning;
12. Dam failure;
13. Tsunamis (added);
14. Hazardous materials (deleted); and
15. Manmade hazards (deleted).

The SHMT approved this updated hazard list at its April 25, 2007 meeting.

The initial hazard identification cataloged potential hazards statewide and determined which have the most chance of significantly affecting the state and its citizens. The hazards include both ones that have occurred in the past as well as those that may occur in the future. A variety of sources were used in the investigation. These included national, regional, and local sources such as websites, published documents, databases, and maps. Some of the specific sources include:

- Alabama Emergency Management Agency;
- United States Geological Survey (USGS);
- Alabama Disaster Center;

- United States Environmental Protection Agency (EPA);
- Alabama Forestry Commission;
- National Oceanic & Atmospheric Administration (NOAA);
- State of Alabama Geological Survey;
- Alabama Department of Economic and Community Affairs (ADECA);
- Agency for Toxic Substances and Disease Registry (ATSDR); and
- Federal Emergency Management Agency (FEMA).

These sources were all revisited during the plan update process with the exception of the EPA and ATSDR. These were not revisited since it was determined that the profile for hazardous material incidents would not be updated.

An important source for identifying hazards that can affect the State is the record of Federal Disaster Declarations. Since 1960, various parts of Alabama were declared Federal Disaster Areas. On three occasions, the entire State was included in a declaration. The southern counties in the coastal regions are mostly affected by hurricanes and coastal storms, while the northern counties of the State are affected by tornados and ice storms, the latter of which may also be accompanied by flooding. **Table 5.2-1** shows the Federal Disaster Declarations in the State from 1960 through June 2007.

Table 5.2-1
Federal Disaster Declarations in Alabama (Updated)

Date	Type of Incident	# of Counties Declared
February 27, 1961	Floods	Info not available
November 7, 1969	Hurricane Camille	2
April 9, 1970	Heavy Rain, Tornados and Flooding	2
March 27, 1973	Tornados and Flooding	28
May 29, 1973	Severe Storms and Flooding	12
April 4, 1974	Tornados	20
January 18, 1975	Tornados	5
March 14, 1975	Severe Storms and Flooding	23
April 23, 1975	Severe Storms and Flooding	8
October 2, 1975	Severe Storms, Tornados and Flooding	15
April 24, 1976	Tornados	2
April 9, 1977	Severe Storms and Flooding	9
July 20, 1977	Drought	67
August 9, 1978	Severe Storms and Flooding	1
March 17, 1979	Flooding	9
April 18, 1979	Storms, Wind, and Flooding	28
September 13, 1979	Hurricane Frederic	11
April 20, 1980	Severe Storms, Tornados and Flooding	2
April 10, 1981	Severe Storms, Tornados and Flooding	1
May 14, 1981	Severe Storms and Flooding	1
December 13, 1983	Severe Storms, Tornados and Flooding	4
May 11, 1984	Severe Storms and Tornados	4
September 7, 1985	Hurricane Elena	2
November 17, 1989	Severe Storms and Tornados	2
February 17, 1990	Severe Storms, Tornados and Flooding	27
March 21, 1990	Severe Storms, Tornados and Flooding	33
January 4, 1991	Severe Storms and Flooding	12

Table 5.2-1
Federal Disaster Declarations in Alabama (Updated)

Date	Type of Incident	# of Counties Declared
March 15, 1993	Severe Snowfall and Winter Storm	67
March 3, 1994	Severe Winter Storms, Freezing and Flooding	10
March 30, 1994	Severe Storms, Tornados and Flooding	7
July 8, 1994	Severe Storms and Flooding – Tropical Storm Alberto	10
April 21, 1995	Severe Storms, Tornados and Flooding	5
October 4, 1995	Hurricane Opal	38
February 23, 1996	Severe Winter Storms, Ice and Flooding	14
March 20, 1996	Severe Storms, Tornados and Flooding	3
July 25, 1997	Hurricane Danny	3
March 9, 1998	Flooding, Severe Storm	6
April 9, 1998	Thunderstorms, Tornado	6
September 30, 1998	Hurricane Georges	14
January 15, 1999	Ice Storm, Freezing Rain	11
February 18, 2000	Winter Storm	3
March 17, 2000	Severe Storm, Flooding	2
December 18, 2000	Tornado	11
March 5, 2001	Severe Storm, Flooding	6
December 7, 2001	Severe Storm, Tornado	19
October 9, 2002	Tropical Storm Isidore	2
November 14, 2002	Severe Storm, Tornado	29
May 12, 2003	Severe Storm, Thunderstorms, Tornado, Flooding	24
September 15, 2004	Hurricane Ivan	67
July 10, 2005	Hurricane Dennis	45
August 29, 2005	Hurricane Katrina	22
March 1, 2007	Severe Storms and Tornados	7

Source: Federal Emergency Management Agency

The following subsections include the results of the hazard identification and profiling process. **Section 5.5** provides detailed risk assessments for the most significant hazards in the State, as identified through a process described in **Section 5.3**. The process used to identify these most significant hazards was reviewed and endorsed by the SHMT during its April 8, 2004 general meeting. This process was revisited with the SHMT at the April 25, 2007 meeting and was endorsed again with the hazards being floods, high winds, and earthquakes.

Section 5.3 includes qualitative probability and mitigation potential ratings for all hazards addressed in this section. This qualitative rating is included at the end of each hazard profiled discussed in this section as a way to address the issue of probability without undertaking detailed studies for all the hazards.

As part of the plan update process, the hazard profile sections of all 66 available local hazard mitigation plans were reviewed to determine what hazards were identified and profiled by local jurisdictions. This process is better described in **Section 7.3**. Some local plans simply provided a table listing what hazards affect the local jurisdictions and what hazards do not. Others provided a ranking system. For the purposes of using consistent information, this plan update discusses hazards that are identified and profiled in the local plans.

Hazard Profiles and Previous Occurrences

The hazards were examined methodically based on the following three aspects, with each aspect considered in detail for the hazards profiled:

- **Nature of the Hazard:** This topic provides basic information about the hazard to explain its nature and distinguish it from other hazards. It also provides a basis for leaders to understand the subsequent vulnerability assessment and loss estimates. The information for this section is drawn mainly from FEMA and other national agencies. For the plan update, these sections were revised to give a general description of the hazard as it occurs in the State of Alabama. **The general descriptions of each hazard were moved to Appendix H.**

- **History of the Hazard:** This section provides background information about previous occurrences. The focus is on disasters and other events that have occurred in Alabama. The information in this section is drawn mainly from the database of historical hazard events in Alabama. In addition to querying the NCDC database and other standard hazard information sources, the plan update includes information on historical hazards that was garnered from the State Agency representatives on the SHMT. The plan update includes discussions of the hazard events that have taken place since the initial plan adoption.

- **Probability of the Hazard:** This section discusses the probability (frequency) of the various hazards. The information in this section is drawn from a combination of FEMA and other national sources, state expertise, and the NCDC Storm Event Database for Alabama. Where possible, the probability is discussed in terms of a commonly accepted design event, i.e., the 100-year flood. For the plan update, the probability of each hazard was reviewed and revised in cases where better information was available.

5.2.1 Flooding

Nature of the Hazard in Alabama

Flooding caused by rainfall occurs to some extent almost every year in almost every part of Alabama. Flooding occurs most frequently between November and April, with a peak from February through April. Alabama receives more annual rainfall than any other state, creating a high potential for riverine and flash flooding.

Additionally, Mobile and Baldwin Counties are located on the coast of the Gulf of Mexico, creating a high potential for coastal flooding due to storm surge that accompanies tropical storms, hurricanes, and coastal storms (the winds associated with hurricanes are discussed in Section 5.2.2). Areas in these two counties that are vulnerable to storm surge flooding are shown in **Figures 5.2-1** and **5.2-2**. These maps were obtained from the Mobile District USACE website in May 2007 but were completed in 1999. More recent maps are not available at this time, but funds are being pursued to develop them.

A review of available local hazard mitigation plans revealed that all 66 county plans identified flooding as a hazard to which they are vulnerable.

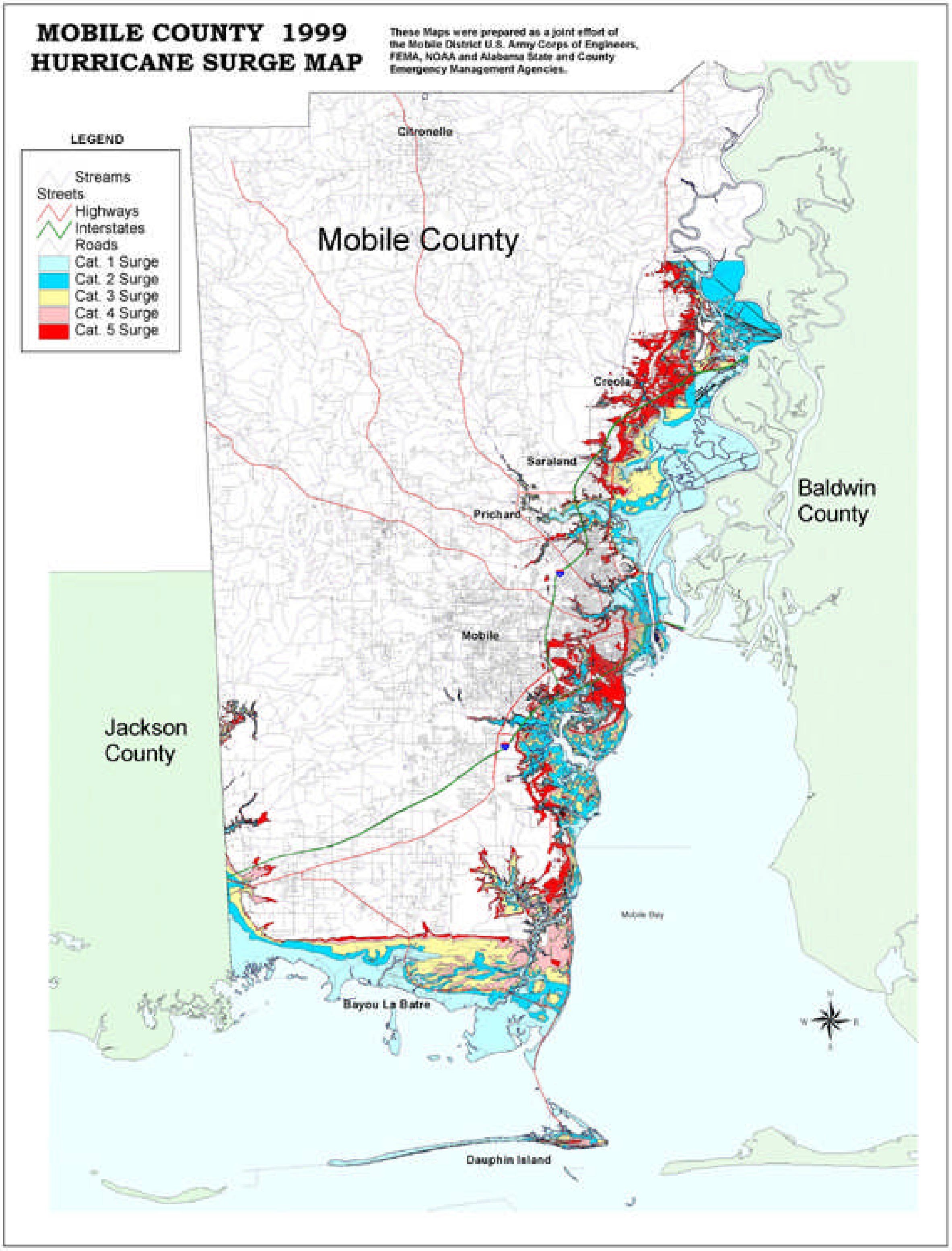


Figure 5.2-1
Mobile County Hurricane Surge Map
Source: Mobile District - United States Army Corps of Engineers

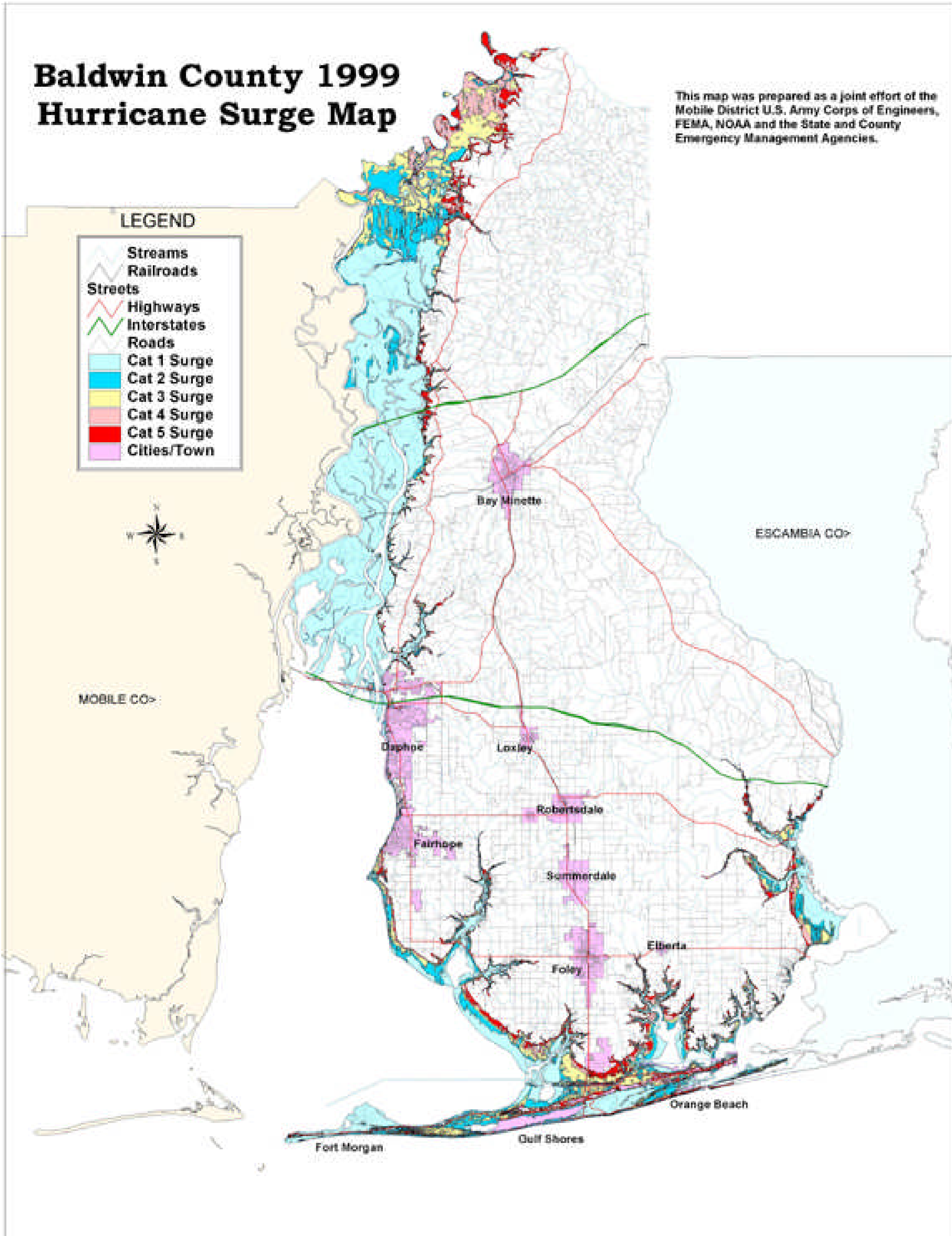


Figure 5.2-2
Baldwin County Hurricane Surge Map
Source: Mobile District - United States Army Corps of Engineers, 2007

Flood History in Alabama

Non-Hurricane Related Flood History in Alabama

During the 12-month period from February 1990 to January 1991, 63 of 67 counties in the state were included in Presidential Disaster Declarations for flooding. In February 1990, a flood disaster occurred from saturation flooding and the inability of the drainage system to accommodate the large volume of water dumped on the central and northeast parts of the state during the first half of the month. Twenty-seven counties in central and northeastern Alabama received disaster declarations due to repetitive rains over a 15-day period. These counties extend through the central and northeast portion of the state.

Immediately following the February 1990 floods, 33 counties in southern Alabama were included in a March 21, 1990 Disaster Declaration caused by a series of strong thunderstorms that continuously formed and moved over the same area. With rain falling nearly parallel to the affected river basins, flooding was more severe than in the past flood events, where rain fell across the basins. The United States Geological Survey (USGS) reported a greater than 100-year flood event on the Choctawhatchee River at Blue Springs and Newton, on the Pea River near Ariton, and on the Conecuh River at Brantley. Flooding along the Alabama River in Selma and Montgomery was characterized as a 50-year event (NOAA, 1997).

In January 1991, 12 north Alabama counties were declared Federal Disaster Areas resulting from weather conditions over a four-day period. A slow-moving weather front produced a “train-echo” effect in the continuous formation and northeastward movement of thunderstorms over the area. The rainfall amounts across north Alabama spanned from 10 to nearly 16 inches. The water level in rivers and creeks equaled the 1973 record flood. The majority of the damage from this flood was in Madison and Morgan Counties. Four of these counties (Cullman, Jackson, Morgan, and Marshall) were also included in the February 1990 Declaration discussed above.

On February 5 and 6, 2004, heavy rains fell across a northern section of the state extending from Sumter to DeKalb Counties. Doppler radar estimated as much as 8 inches of rainfall fell across some areas. Several roads were temporarily impassable. Numerous creeks and streams quickly rose out of their banks and caused flooding. One railroad trestle was flooded. One highway bridge was completely washed away. Water was standing in yards and fields in some places. Several roads were temporarily impassable. A bridge along State Road 17 was washed out and several other small bridges were washed out. Up to 30 homes were flooded in Jefferson County. Damage was estimated at $337,000.

From November 22-24, 2004, up to 4-5 inches of rain (with some areas as high as 12 inches) fell on already saturated grounds causing flash flooding in an area of the State between Tuscaloosa, DeKalb, and Clay counties. A potential dam break situation developed in the afternoon in St. Clair County. The dam eventually failed near the Friendship Community, resulting in significant damage. Runoff from these storms lasted for several hours after the heaviest rains ended. One fatality was reported. In other counties, numerous roads were reported covered with water and were temporarily impassable. Total damages were estimated to be $946,000.

Several days of heavy rains between March 27 and April 6, 2005 caused severe flooding across the southern two thirds of the State. In Mobile and Baldwin Counties, as much as 20 inches fell, causing damages to bridges and roadways. In Choctaw County, one fatality was reported when a man tried to cross a bridge that washed away. Two bridges, a retaining wall, and a culvert were totally destroyed in Auburn. Damage estimates across the region were $1,056,000.

On July 26, 2005, heavy rains fell in Jefferson and Lee Counties causing significant flooding in both Birmingham and Auburn. In Auburn, water was up to 4 feet deep across several roadways. Several automobiles were damaged by flood waters. Damage in Auburn was estimated at $75,000. Numerous streets and creeks were flooded all over the City of Birmingham. At least 25,000 customers were without power during the storms. Local fire departments performed at least 11 swift water rescues. Patton Creek in Vestavia Hills overflowed its banks flooding several homes and businesses. Royal Automotive and Vulcan Lincoln-Mercury reported 40 to 50 vehicles damaged and 4 or 5 destroyed. The Vestavia Bowl Family Fun Center received damage due to high water. At least 15 vehicles were stalled in the high water. Damage in Birmingham was estimated at $500,000.

Hurricane Related Flood History in Alabama
Since 1960, Alabama has been a part of 11 disaster declarations caused by hurricanes and tropical storms.

Table 5.2-2
Disaster Declarations from Hurricanes in Alabama

Date	Name
November 1969	Camille
September 1979	Frederic
September 1985	Elena
July 1994	Alberto
October 1995	Opal
July 1997	Danny
September 1998	Georges
September 2002	Isidore
September 2004	Ivan
July 2005	Dennis
August 2005	Katrina

Source: FEMA, May 2007

One of Alabama's costliest hurricanes was Hurricane Frederic, a Category 3 event that resulted in widespread damage in south and southwest Alabama. Frederic came ashore on September 12, 1979 and caused enormous damage to parts of Alabama, Florida, and Mississippi. Hurricane Frederic moved over Dauphin Island (near the mouth of Mobile Bay) and inland just west of Mobile, Alabama with a storm surge of 8 to 12 feet above normal tide from Pascagoula, Mississippi to western Santa Rosa Island, Florida. The damage estimate of Frederic was $2.3 billion.

Hurricane Elena, a Category 3 storm, made landfall on September 2, 1985, causing extensive damage along the Florida, Mississippi, and Alabama coasts. The eye of the storm passed 30 miles south of Mobile, battering Gulf Shores in Baldwin County, and Dauphin Island in Mobile County. Hurricane tides reached 6 to 8 feet, primarily in an area from Dauphin Island west to Gulfport. Rainfall amounts were relatively light, with 2.35 inches reported in Mobile. The Dauphin Island Sea Lab reported 3.00 inches of rain from Hurricane Elena. Two counties were declared Federal Disaster Areas on September 7, 1985 due to Elena. Most of the damage from Elena was caused by wind, with additional damage from storm surge and wave action. Shoreline properties in Baldwin and Mobile Counties were affected with the most extensive damage concentrated on the western end of Dauphin Island.

On July 3, 1994, Tropical Storm Alberto made landfall in the Destin, Florida/Choctawhatchee Bay area. A lack of upper air movement caused the storm to stall over Alabama and Georgia until July 8. Because the storm did not move far from the Gulf or the Atlantic, it continued to bring moisture from both of these sources into the system. The effects of Tropical Storm Alberto can be compared to Hurricane Juan in 1985, which stalled and caused severe flood damage in Louisiana. The most serious and devastating flooding from Alberto occurred along the Choctawhatchee and Pea Rivers as one of the worst floods in Alabama history. In the modern period of record, only the Great Flood of March 1929 and the more recent flood in March 1990 have been more severe than this flood. Other significant flooding from the same event occurred along the Chattahoochee River, Shoal River, Yellow River, Conecuh River, and lower Tallapoosa River (NOAA, 1997). The ten southern counties affected in the July 1994 disaster declaration lie predominantly in the Choctawhatchee, Pea, Conecuh, and Chattahoochee River watersheds. These rivers are fed by tributaries, including the Little Choctawhatchee and Chipola Rivers, Whitewater, Patrick, Newton, Cowarts, Limestone, Beaver, Double Bridges, Wedowee, Frog Level, Murder, Uchee, Little Uchee, Hatchechubee, Otter, Shack, Hunter, Tomley, Cane, and Claybank Creeks.

Three hurricanes impacted Alabama in 1995. Hurricane Allison caused a scare to Alabama and Florida residents in June of that year. There was relatively little damage, and Alabama was affected only by the evacuees from the Florida coast. Hurricane Erin in August caused extensive crop damage in Escambia County and damages in Baldwin, Washington, Clarke, and other southwestern counties. For Alabama, Hurricane Opal was the most devastating hurricane of the 1995.

In October 1995 Hurricane Opal rushed across the panhandle of Florida and into Alabama, resulting in a presidential disaster declaration for 38 counties on October 4, 1995. Opal made landfall near Hurlburt Field, just east of Fort Walton Beach, Florida, on Wednesday, October 4, 1995. Damages extended beyond the Alabama borders into Georgia, North Carolina, South Carolina, and further north all the way to the Great Lakes area. In the coastal Alabama counties of Baldwin and Mobile, storm surge severely eroded beaches; damaged piers, docks, boats and roads; and flooded low-lying areas. Heavy rains, accompanying Opal caused inland flooding. Hurricane Opal pushed an 8 foot storm surge onto Alabama's Gulf Coast. This surge leveled much of the primary dune system. The storm surge covered the coast in a mountain of sand that submerged gulf-front roads, crushed the ground floor and foundation of beach homes and condominiums and filled swimming pools with sand. The overall effect of Hurricane Opal was a displacement of sand, destruction of the primary dune system, and overall narrowing of the beach in many areas.

Hurricane Danny was the only hurricane that made landfall in the United States during the 1997 Atlantic hurricane season. After crossing the southeastern-most portion of Louisiana, Danny stalled over the Mobile Bay dropping a State record 36.71 inches of rainfall on Dauphin Island. A storm surge of over 6.5 feet occurred off of Highway 182, midway between Gulf Shores and Fort Morgan, Alabama, in addition to the rainfall. Approximately $63 million of damage was done to property and crops, mostly from flooding. Additionally, the flooding caused significant coastal erosion along the Gulf Coast and rescues had to be performed from many flooded areas. Two fatalities, one direct and one indirect, were a result of the hurricane. Numerous roads were flooded and impassable for several days.

Hurricane Ivan made landfall on September 16, 2004 in Gulf Shores, on the coast of Baldwin County Alabama as a strong Category 3 hurricane with 130 mph winds and a storm surge estimated to be between 10 and 13 feet high. Ivan's storm surge easily overwhelmed the dunes that provide protection foe coastal areas of Baldwin and Mobile Counties. The Gulf of Mexico spilled into the developed areas pushing massive amounts of earth landward undermining buildings and roads and opening breaches through the islands. On top of the surge, waves crashed down onto the already battered roads and infrastructure, substantially worsening the damage. According to the USGS, Ivan washed away as much as much as 164 feet of beach in places. The erosion caused by Ivan's waves and storm surge undermined five-story oceanfront condominium buildings, which were the largest buildings to fail during a hurricane in United States history to that point. The average shoreline erosion was 42 feet in the area where Ivan came ashore, roughly between Alabama's Mobile Bay and Florida's Pensacola Bay in Florida. Ivan also caused flash flooding in inland counties throughout the State.

Hurricane Dennis made landfall on July 10, 2005 at the Santa Rosa Sound in Florida, approximately 25 miles from the Florida-Alabama state line. At this time, Alabama had already received significant rainfall from Tropical Storm Arlene and Hurricane Cindy. Because coastal Alabama was on the western side of the eye of Dennis, it was spared the worst of the storm surge; however, as much as 10 inches of rain fell in some areas causing flash flooding in inland counties throughout the State.

Hurricane Katrina made landfall along the Louisiana-Mississippi border on August 29, 2005, approximately 80 miles east of the Mississippi-Alabama border. While Louisiana and Mississippi received the most catastrophic flood damage, because Alabama was on the eastern side of the system, Mobile County experienced a significant storm surge, higher than in Ivan just the year before. Storm surge throughout coastal Mobile and Baldwin Counties ranged from 9-14 feet. As Katrina moved inland, it dropped huge amounts of rain throughout the State causing significant flash flooding in inland areas.

Probability of Flooding in Alabama

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in any given year. The most widely adopted design and regulatory standard for floods in the United States is the 1-percent annual chance flood and this is the standard formally adopted by FEMA. The 1-percent annual flood, also known as the base flood, has a 1 percent chance of occurring in any particular year. It is also often referred to as the "100-year flood" since its probability of occurrence suggests it should only occur once every 100 years. This expression is, however, merely a simple and general way to express the statistical likelihood of a flood; actual recurrence periods are variable from place to place.

Smaller floods occur more often than larger (deeper and more widespread) floods. Thus, a "10-year" flood has a greater likelihood of occurring than a "100-year" flood. **Table 5.2-3** shows a range of flood recurrence intervals and their probabilities of occurrence.

Table 5.2-3
Flood Probability Terms

Flood Recurrence Intervals	Percent Chance of Occurrence Annually
10-year	10.0%
50-year	2.0%
100-year	1.0%
500-year	0.2%

Source: FEMA, August 2001

In addition, Alabama has been significantly affected by flooding caused by tropical storms and hurricanes 11 times (i.e. disaster declared) in the last 47 years. This historical average indicates that flooding from hurricanes will cause significant damage in Alabama approximately once every 4.27 years or an approximate 23.4 percent annual probability.

Because the impacts of flooding are severe and events can occur throughout the State and can be widespread, the qualitative ranking for probability for flooding is high.

5.2.2 High Winds (Hurricanes, Tornados and Windstorms)

Nature of the Hazard in Alabama

Figure 5.2-3 shows the different wind zones throughout the State of Alabama used by the American Society of Civil Engineers (ASCE) for determining design wind speeds. Design wind speeds are used by engineers to determine what type of winds (i.e. how strong) a building should be designed to withstand.

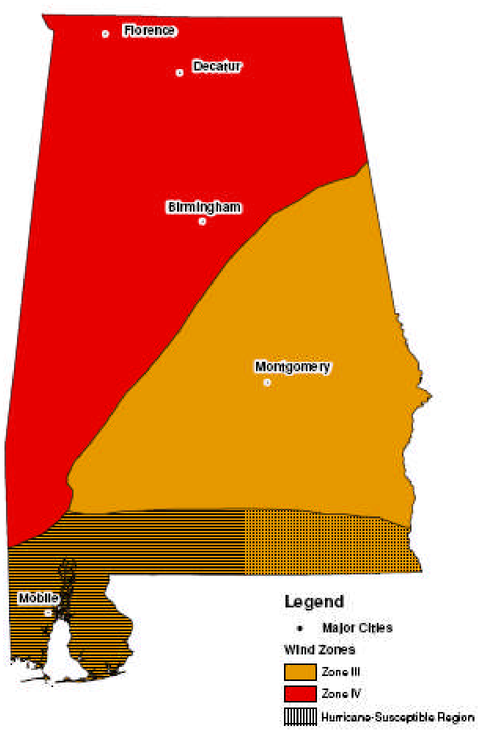


Figure 5.2-3
Design Wind Speeds (3 second gust)*
Source: ASCE 7-98

***Zone 3 represents 200 mph; Zone 4 represents 250 mph**

The two coastal counties of Alabama are the most prone to receiving high winds caused by hurricanes. Hurricanes make landfall at full strength before wind speeds rapidly deteriorate as the storm loses its energy source, the warm ocean waters of the Gulf of Mexico. However, as demonstrated in **Figure 5.2-4**, if a fast moving Category 4 hurricane hits the State of Alabama, the lower two thirds of the State are prone to receiving hurricane force winds (>74 mph). Even the northernmost portion of the State is capable of receiving winds in excess of 58 mph for that same storm. As demonstrated in **Figure 5.2-5**, even a typical Category 2 hurricane is capable of spreading tropical storm force winds (>39 mph) over nearly the entire state with areas as far north as Montgomery receiving winds in excess of 58 mph.

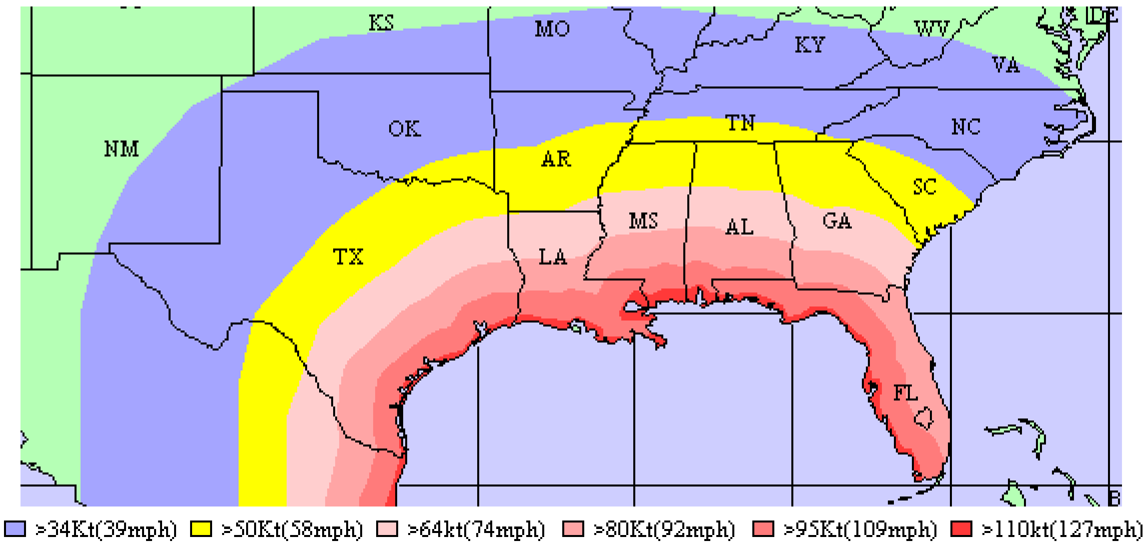


Figure 5.2-4
Extent of Inland Winds for a Category 4 Hurricane Moving Forward at 25 mph
Source: National Hurricane Center

Essentially the inland extent of winds as well as wind strength increases with the strength of the hurricane at landfall and the actual forward motion of the storm.

The entire state is vulnerable to high winds caused by tornados. The most likely time for tornados is during the spring months from March through April and into May, with a secondary peak of activity in November; however tornados have occurred in every month of the year in Alabama.

A review of available local hazard mitigation plans revealed that all 66 counties identified hurricane winds and tornados as hazards to which they are vulnerable.

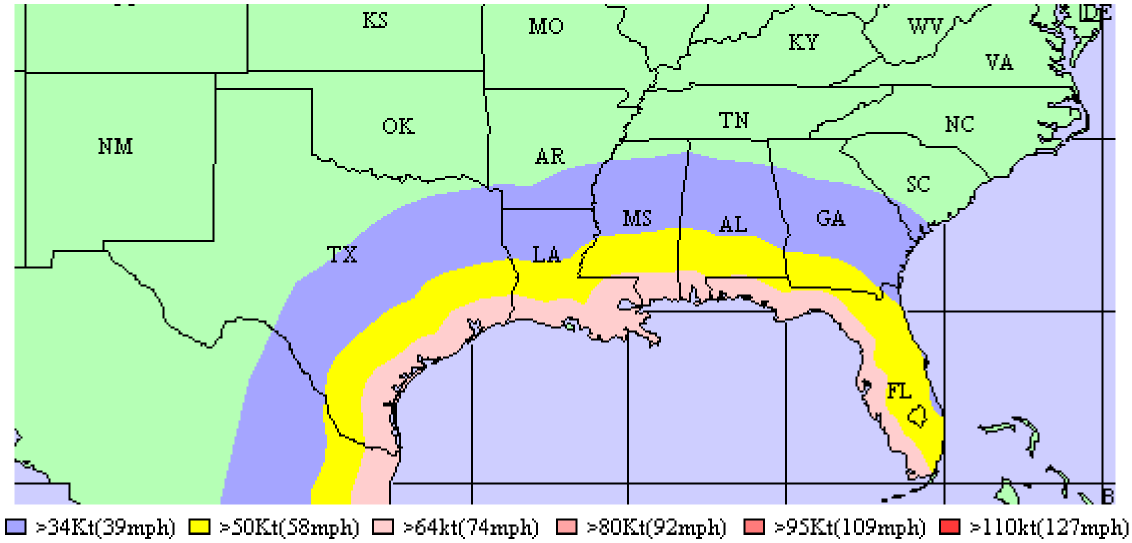


Figure 5.2-5
Extent of Inland Winds for a Category 2 Hurricane
Moving Forward at 14 mph
Source: National Hurricane Center

High Wind History in Alabama

Hurricane Related High Wind History in Alabama

One of Alabama's costliest hurricanes was Hurricane Frederic, a Category 3 event that resulted in widespread damage in south and southwest Alabama. Frederic came ashore on September 12, 1979 and caused enormous damage to parts of Alabama, Florida, and Mississippi. With winds reaching 145 miles per hour, Hurricane Frederic moved over Dauphin Island (near the mouth of Mobile Bay) and inland just west of Mobile, Alabama. The damage estimate of Frederic was $2.3 billion. Based on information from emergency preparedness officials, 250,000 people were safely evacuated in advance of Frederic. Eleven counties were included in the Federal Disaster Declaration: Baldwin, Choctaw, Clarke, Conecuh, Covington, Escambia, Geneva, Marengo, Mobile, Monroe, and Washington. The hurricane impact area comprised 20.5 percent of the total land area of the State of Alabama.

Hurricane Elena, a Category 3 storm with sustained winds of 124 miles per hour, made landfall on September 2, 1985, causing extensive damage along the Florida, Mississippi, and Alabama coasts. The eye of the storm passed 30 miles south of Mobile, battering Gulf Shores in Baldwin County, and Dauphin Island in Mobile County. Wind gusts were estimated at up to 132 miles per hour on Dauphin Island. Two counties were declared Federal Disaster Areas on September 7, 1985 due to Elena. Most of the damage from Elena was caused by wind, with additional damage from storm surge and wave action. Shoreline properties in Baldwin and Mobile Counties were affected with the most extensive damage concentrated on the western end of Dauphin Island.

In October 1995 Hurricane Opal rushed across the panhandle of Florida and into Alabama, resulting in a presidential disaster declaration for 38 counties on October 4, 1995. Damages extended beyond the Alabama borders into Georgia, North Carolina, South Carolina, and further north all the way to the Great Lakes area. Wind speeds at landfall were 125 miles per hour. In the coastal Alabama communities of Baldwin and Mobile, causing blocked roads and downed power lines. The storm's passage left six people dead in Alabama and thousands without power in Alabama. More than half of the Alabama's counties were included in the disaster declaration areas. The affected counties were concentrated in the eastern half of Alabama and along the southern border westward to the Mississippi line. The area contained a total population of 2,982,088, and included the three largest cities in the state, Birmingham, Mobile, and Montgomery (NOAA, 1997).

Beginning in the evening of July 18 and continuing through the morning of July 19th, 1997, Hurricane Danny came ashore through Mobile Bay. Danny had sustained winds of around 85 miles per hour. The most severe wind damage was concentrated in the Fort Morgan and West Beach areas of Gulf Shores and Dauphin Island. Most of the damage to homes and businesses was roof and water damage and broken windows. Most of the businesses were able to reopen within a day or two after the storm with the exception of some condominiums and hotels. As a result of the storm, three counties were declared disaster areas and received federal assistance to help aid in repairs.

Hurricane Ivan made landfall on September 16, 2004 near Gulf Shores in Baldwin County as a strong Category 3 hurricane. The city of Demopolis, over 100 miles inland in west-central Alabama, endured wind gusts estimated at 90 mph (150 km/h), while Montgomery saw wind gusts in the 60–70 mph (95–115 km/h) range at the height of the storm. In Baldwin County, the coastal areas from Fort Morgan to Gulf Shores to Orange Beach saw the worst damage from a hurricane in over a hundred years. As Ivan moved ashore during the morning hours of September 16th, the winds caused major damage to trees along and east of the track of the storm. Hurricane force winds were felt across the entire area, including many inland counties. Most of the area probably had hurricane force winds for two to four hours causing 100 year old trees to break and damage homes and vehicles. While some structural wind damage would have been expected, most of the major structural damage that occurred over inland areas would not have been as substantial if it had not been for fallen trees. It was estimated that in Alabama over $500,000,000 in damages was done to timber. Power was out for over a week across inland areas and several weeks along the immediate coast as the infrastructure was rebuilt. Agriculture interests suffered a major with significant damages to the cotton, soybean, and pecan crops. In fact, the soybean and pecan crops were nearly destroyed. Five deaths in Alabama were attributed to Hurricane Ivan in Alabama. While the entire State was declared a Federal Disaster Area, it will be remembered as one of the most damaging hurricanes to affect the Baldwin, Escambia, Clarke, Monroe, Conecuh and Butler Counties in southwest Alabama.

Hurricane Dennis made landfall as a Category 3 hurricane on the western Florida panhandle before rapidly deteriorating in organization and strength while moving across southwest Alabama. Most of the damage was a result of strong winds associated with Dennis' passing rain bands. Trees were knocked down, debris was scattered on roads and power outages were common throughout the State. All but the 20 northernmost counties were declared a disaster.

Hurricane Katrina made landfall along the Louisiana and Mississippi Gulf Coasts on August 29, 2005 as a strong Category 3 hurricane before moving inland along the Mississippi-Alabama border. Katrina's winds had impacts that were widespread across western and central Alabama. Thousands of trees and power lines were brought down, minor to major structural damage occurred, and power outages were lengthy and widespread. Several locations remained without power for over a week. Six tornados occurred across central Alabama in association with Katrina, Four F0's and two F1's. Alabama Power reported that this was the worst event in their history for damage and power outages statewide. Sustained winds of 67 mph were recorded in Mobile while gusts up to 80 mph may have been possible in locations west of a line from Selma to Hamilton. Tropical storm force winds (>34 mph) were felt throughout northern Alabama. Twenty-two counties in the western half of the State were declared a Federal Disaster Area.

Tornado Related High Wind History in Alabama

Records show that hundreds of tornados touched down in Alabama between 1916 and 1990, killing over 900 people. It is not uncommon for multiple tornados to strike at about the same time. The most tragic tornado event in Alabama occurred on March 21, 1932, when seven tornados ripped through a dozen central and northeastern Alabama counties, leaving 268 people dead and 1,834 injured. Tornados were cited as responsible or partially responsible for the damages in six of the declared major disasters between April 1974 and February 1990.

The “Super Outbreak” of tornados occurred on April 3, 1974, between 3 and 9 p.m. At least seven tornados killed 86 people and injured 938. The following day, April 4, 1974, 20 counties were declared federal disaster areas. Other tragically destructive tornados were the Demopolis-Greensboro- Brent- Woodsonville- Mt. Cheaha tornado of May 27, 1973, the Northwest Birmingham tornado of April 4, 1977, and the Huntsville tornado of November 15, 1989.

On March 30, 1994, the President declared seven counties in north Alabama major disaster areas resulting from tornados, flooding, and severe storms that struck the region on March 27, 1994. The storms moved across northeast Alabama to the Georgia state line, spawning tornados, flooding, and straight-line winds. They killed 22 people, injured over 150, and caused extensive property damage. Based on a search of existing records, it appears that the 50-mile long tornado path of the Cherokee County storm places it among the longest tornado tracks experienced in Alabama since 1950.

Severe storms that began on February 15 and continued through February 20, 1995 produced high winds, rain, and tornados across north Alabama. The National Weather Service confirmed three tornados, one of which was an F-3 event that passed through the northern part of the state. On April 21, 1995, President Clinton issued a major disaster declaration for the five Alabama counties of Cullman, DeKalb, Marion, Marshall, and Winston. In the community of Arab, five people died as a result of the storms. Across the five counties, more than 30 people were injured and close to 300 homes and farm buildings were damaged. Because of the heavy rains accompanying the storms, some flooding occurred in DeKalb County that impacted several roads and bridges.

From 2004-2006, there were no tornados in Alabama greater than an F2 on the Fujita Scale. One of the larger tornados occurred on November 15, 2006, when an F2 tornado touched down in Montgomery approximately 1.4 miles southwest of the Shakespeare Festival and tracked northeastward across the Woodmere and Beauvoir Lakes Subdivisions. Numerous trees were snapped off or downed along the path with minor roof damage to numerous homes. Near the Atlanta Highway, the tornado crossed an athletic field complex and struck the Montgomery Postal Processing and Distribution Center and Post Office. The main doors of the post office were blown in and portions of the roof were lifted off to the north. Numerous trees were snapped off at ground level on the south and west sides of the building. A tractor trailer was completely turned around, moved 30 yards, and flipped. Other postal vehicles and cars in the parking lot were moved or received significant damage. Just to the north, the tornado produced major damage to the Fun Zone Skating Rink. This was a large metal structure which was almost totally destroyed. Several vehicles were tossed around and significantly damaged or crushed by debris from the building. As the tornado crossed the Atlanta Highway, several metal power poles were either significantly bent or downed. At the Saddleback Ridge Apartment Complex, at least two apartment buildings lost their roofs and portions of the second floor. The tornado continued another 2.25 miles northeastward, ending in a field just south of Wares Ferry Road.

Most recently, on March 1, 2007, 12 tornados touched down throughout the State of Alabama, two of which were EF4s on the new Enhanced Fujita Scale (this scale is discussed under the general description of tornados contained in **Appendix H**). The first occurred in Wilcox County causing one death and significant damage to about 70 homes. The other developed near the Enterprise Municipal Airport in Coffee County. The tornado left severe damage throughout a large section of the City. The most severe damage took place at Enterprise High School, where a section of the school was destroyed during the middle of the school day. Eight fatalities were reported at the school and 121 others were taken to local hospitals. At the school, all of the fatalities were a result of a collapsed concrete wall. One hallway completely collapsed, trapping many students in the rubble just outside the music room. The tornado at the school was so strong that it flipped cars over in the parking lot, flattened parts of the stadium and tore trees out of the ground. Nearby Hillcrest Elementary School also sustained severe damage from the tornado. The tornado initially formed in a neighborhood just south of the downtown area; after demolishing a section of the downtown area it moved on to the schools. The tornado then continued northeast crossing the Holly Hill and Dixie Drive areas. A quarter mile wide swath was devastated, with enormous damage reported to many houses and businesses, some of which were flattened. Several other schools and the local YMCA were among the damaged buildings. According to Mayor Kenneth Boswell, at least 370 houses were damaged or destroyed. The tornado itself was estimated to have been 300 yards wide and had a path length of 7 miles. It dissipated shortly after leaving Enterprise.

Table 5.2-4 shows a summary of statewide annual tornadic activity, including deaths, injuries, and property and crop damages from 1950 thru 2006. Due to a lack of available information, data from the 2007 tornados is not included at this time, but will be included as a part of future updates.

Table 5.2-4
Annual Tornado Summary (Updated)

Year	Tornados	Deaths	Injuries	Total Damages
1950	2	0	15	$ 28,000
1951	5	0	13	$ 37,000
1952	13	6	116	$ 5,453,000
1953	22	16	248	$ 3,074,000
1954	10	0	36	$ 609,000
1955	8	5	27	$ 7,581,000
1956	7	25	203	$ 2,553,000
1957	51	10	192	$ 7,227,000
1958	23	1	3	$ 2,062,000
1959	9	0	8	$ 331,000
1960	11	0	2	$ 559,000
1961	24	0	28	$ 2,537,000
1962	11	0	10	$ 928,000
1963	22	3	76	$ 9,228,000
1964	26	12	31	$ 2,159,000
1965	11	0	44	$ 1,353,000
1966	11	1	17	$ 1,128,000
1967	26	5	97	$ 12,753,000

Table 5.2-4
Annual Tornado Summary (Updated)

Year	Tornados	Deaths	Injuries	Total Damages
1968	14	1	46	$ 7,278,000
1969	15	2	16	$ 1,631,000
1970	14	2	16	$ 1,175,000
1971	23	4	16	$ 1,653,000
1972	16	4	95	$ 1,909,000
1973	54	10	408	$ 227,062,000
1974	55	79	959	$ 139,521,000
1975	35	2	142	$ 34,906,000
1976	30	0	204	$ 45,390,000
1977	22	23	144	$ 28,137,000
1978	22	0	49	$ 6,453,000
1979	26	0	44	$ 6,712,000
1980	29	0	26	$ 4,637,000
1981	14	2	90	$ 30,356,000
1982	28	0	18	$ 3,915,000
1983	49	3	101	$ 16,096,000
1984	46	5	60	$ 39,259,000
1985	48	1	31	$ 23,215,000
1986	20	2	14	$ 16,828,000
1987	7	1	0	$ 50,000
1988	20	0	59	$ 31,100,000
1989	25	21	478	$ 521,106,000
1990	19	0	74	$ 17,800,000
1991	10	5	33	$ 3,250,000
1992	28	2	65	$ 21,900,000
1993	10	0	8	$ 500,000
1994	34	22	264	$ 76,260,000
1995	60	7	215	$ 13,260,000
1996	68	7	87	$ 17,751,000
1997	40	1	47	$ 15,806,000
1998	64	34	275	$ 211,124,000
1999	49	0	1	$ 808,000
2000	74	13	179	$ 37,295,000
2001	77	6	107	$ 14,841,000
2002	55	13	131	$ 17,346,000
2003	60	0	80	$ 3,079,000
2004	65	1	23	$ 8,637,000
2005	86	0	8	$ 4,741,000
2006	75	1	13	$ 8,976,000
Total	1,778	360	5,720	$ 1,721,363,000
Avg/year	38	8	122	$ 36,624,000

Source: National Climatic Data Center

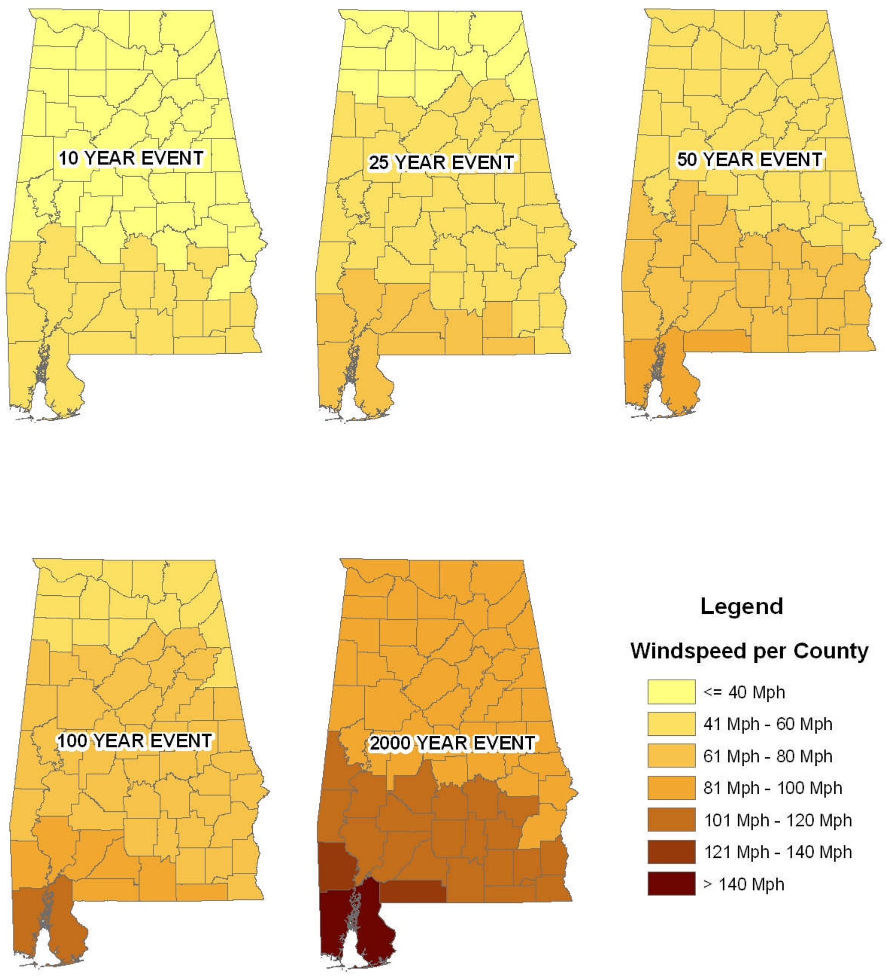
Probability of High Winds in Alabama

Alabama has been significantly affected by high winds caused by tropical storms and hurricanes 11 times (i.e. disaster declared) in the last 47 years. This historical average indicates that high winds from a hurricane will cause significant damage in Alabama approximately once every 4.27 years or an approximate 23.4 percent annual probability.

Figure 5.2-6 shows the maximum expected one-minute, open terrain, sustained wind speeds from hurricanes for 10, 25, 50, 100, and 2000 year return periods as determined by FEMA. Because the impacts of these high winds are severe and events can occur throughout the State and can be widespread, the qualitative ranking for probability for high winds is high.

Although exact tornado probability is impossible to determine, given the relatively long reporting period, it is reasonable to assume that the average annual statewide figure cited in **Table 5.2-4** (38 per year) will remain relatively constant in the future. Note however, the numbers of deaths, injuries, and dollar amount of damages can fluctuate drastically depending on the severity of the tornados and the locations that they impact.

Figure 5.2-6
Probabilistic Maximum Sustained Wind Speeds



5.2.3 Winter Storms

Nature of the Hazard in Alabama

This section describes winter storms as they occur throughout the State of Alabama. Winter storms in Alabama are not as severe or common as winter storms in the northern states. Typically, a winter storm in Alabama consists of freezing rain or a few inches of snow that may or may not be accompanied by frozen roadways. However, because the State and it citizens are unaccustomed to them, they tend to be very disruptive to transportation and commerce. Trees, cars, roads, and other surfaces develop a coating or glaze of ice, making even small accumulations of ice extremely hazardous to motorists and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways that lead to vehicle and pedestrian accidents; collapsed roofs from fallen trees and limbs and heavy ice and snow loads; and felled trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe ice storms, telecommunications and power can be disrupted for days. Such storms can also cause exceptionally high rainfall that persists for days, resulting in heavy flooding. A review of available local hazard mitigation plans revealed that 64 out of 66 counties identified winter storms as a hazard to which they are vulnerable.

Winter Storm History in Alabama

Significant ice storms that affected locations in Alabama occurred across the northern two-thirds of Alabama on January 6 and 7, 1988. Ice accumulation was nearly an inch along a line from Tuscaloosa to Birmingham to Anniston. Much of the Tennessee Valley experienced snow, with as much as 10 inches of snow in Huntsville on March 1 to 3, 1980. Additional icing events include the following: January 20, 1983, statewide with the worst conditions across north and central Alabama; January 12, 1982, statewide with the worst conditions across north and central Alabama; January 2, 1977, statewide with worst conditions across north and central Alabama; January 2, 1977, central Alabama; and January 7, 1973, across the Tennessee Valley of north Alabama.

A winter storm described as the worst in Alabama history struck on Friday March 12, 1993 and lasted through mid-day Saturday, March 13, 1993. Snow began falling over north Alabama Friday afternoon, then spread southward overnight, reaching all the way to the Gulf Coast. By mid-day Saturday snow had accumulated to 6 to 12 inches over North Alabama and 2 to 4 inches at the Gulf Coast. A 40-mile-wide band of 12 to 20 inches fell from the Birmingham area northeastward to DeKalb and Cherokee counties, generally following the Appalachian Mountains. It was estimated that 400,000 homes were without electricity, and many remained so for several days. Compounding the snow and power problems, temperatures fell well into the single digits and teens across much of the state Saturday night. There were at least 14 deaths associated with the exposure or stress due from the storm. Damage estimates ranged from $50 and $100 million. The entire state was declared a Federal Disaster Area.

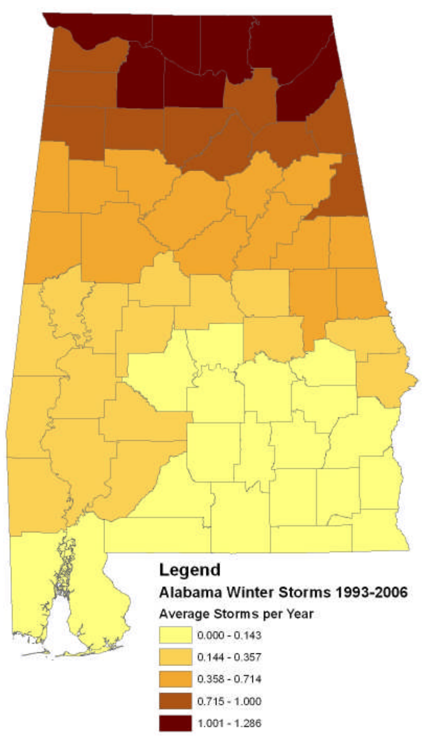
The 1994 declaration for severe winter storms resulted from incidents occurring on January 16 to 18 and February 9, 1994. Cold, dry Arctic air over Alabama from January 16 to 18 was replaced by a warm, moist front. As the low pressure center moved out of the state, cold dry, Arctic air once again moved in with freezing temperatures, causing the wet mud to freeze. Then, on February 9, a stationary cold front retreated northward, bringing moist warmer air behind it. Weak low pressure cells moving along the boundary between cold and warm air masses pushed the warm, moist air up and over the cold surface air creating a shallow layer of near-freezing air at the ground surface. Precipitation, falling from the warm air layer froze on contact with cold surface objects creating a thick coating of ice. Flooding also occurred when debris-blocked channels could not drain off the water from melting ice and thawing soil. Ten counties were declared a Federal Disaster Area.

Since plan adoption in 2004, the only notable winter storm event started on the evening of January 28, 2005 and finished the following afternoon in the northwest portion of the State. One man was slightly injured when the vehicle he was driving slid off the road near Mt. Cheaha in Cleburne County. At least 15 additional vehicles slid off the roadways under the icy conditions. Exposed surfaces had ice accumulation to at least one half of an inch with a few locations reporting ice accumulations of around one inch. Numerous trees, tree limbs, and power lines were knocked down and many of the fallen trees temporarily blocked roadways. Several homes and vehicles were damaged by the fallen trees. Several area bridges became totally iced over and were very hazardous for travel. Power outages were widespread during the early morning hours with up to 30,000 homes and businesses without power. The rain became freezing rain just after sunset on January 28. Icing conditions started in the early evening hours and tapered off to no additional significant accumulations early on January 29. Estimated damages form this storm were approximately $500,000.

Probability of Winter Storms in Alabama

In general, according to recent history winter storms are more likely to affect northern counties more often than southern counties. **Figure 5.2-7** below shows the average number of winter storms per year for each county from 1993-2006. Although it is very difficult to accurately determine future probabilities of any hazard, the history of winter storms in the State suggests that the northern part of Alabama can expect to experience such an event about once a year on average, while southern areas (particularly those along the Gulf coast) will probably experience a severe winter event about once every ten years. As the Figure shows, mid-State areas have winter storm probabilities somewhere between the northern and southern Counties.

Figure 5.2-7
Alabama Winter Storm Return Interval by



5.2.4 Landslides

Nature of the Hazard in Alabama

Throughout the state, almost any steep or rugged terrain is susceptible to landslides under the right conditions. The most hazardous areas are steep slopes on ridges, hills, and mountains; incised stream channels; and slopes excavated for buildings and roads. In Alabama, most landslides generally are confined to specific geologic formations in areas of moderate topographic relief in the northern part of the state. Areas underlain by swelling clays or by interbedded sands and clays of the Cretaceous Tuscaloosa Group are also particularly susceptible to landslides in excavated areas, especially along highways. Undercutting of steep slopes by wave action in Mobile Bay is also a significant problem in south Alabama.

A review of available local hazard mitigation plans revealed that 50 out of 66 counties identified landslides as a hazard to which they are vulnerable.

Landslide History in Alabama

In 1996, geologists discovered the remnant of an ancient landslide at Hokes Bluff, Etowah County, Alabama, which formed a 140-foot hill. This massive landslide once ripped apart Colvin Mountain and sent millions of tons of rock sliding down into the valley floor.

Landslides are common near Huntsville on Monte Sano and Green Mountains in Madison County. In 1993, four areas of recent landslides on Green Mountain were identified as being near some type of development activity on the mountain. In 1997, 400,000 pounds of rock broke away from Monte Sano Mountain and crashed into Governors Drive. In 1998, extensive rainfall associated with a hurricane resulted in a major landslide with large fissures on Monte Sano Mountain (**Photo 5.2-1**). The slide, about 750 feet long and 200 feet wide, began near the top of the mountain in a relatively new neighborhood and threatened to wipe out an older residential area at the base of the mountain. Extensive dewatering and eventual removal of the affected rock prevented a major disaster.

Photo 5.2-1
Fissures near top of incipient landslide on Monte Sano Mountain in Huntsville, Madison County 1998

Landslides are particularly a problem on the steep slopes of the Alabama Valley and Ridge of northeast Alabama. North of Gadsden in Etowah County, the southbound lane of Interstate 59 slid from its perch on a mountainside down into the valley below in 1972, resulting in $1.3 million in repairs and prolonged disruption of traffic. In 1998, another landslide in DeKalb County wiped out County Highway 81 on Lookout Mountain. This latter slide moved 117,527 cubic yards of rock (**Photo 5.2-2**) and cost $1.7 million to repair. Other slides on Highway 35 between Rainsville and Fort Payne and on Highways 146 and 71 in Jackson County have cost between one and two million dollars each to repair.

Photo 5.2-2
Landslide on DeKalb County Road 81 on the west side of Lookout Mountain in March 1998

In Birmingham in 1988, a landslide destroyed apartment buildings during the construction of an adjacent Festival Center. Estimated damages were over $10 million.

Near Prattville, Autauga County, County Road 47 was closed by a landslide in 2005. The problem stemmed from unconsolidated sediments that move underneath the road when it rains (**Photo 5.2-3**). A temporary repair was implemented which cost between $150,000 and $200,000, and a more permanent repair is estimated to cost several million dollars, if even feasible.

Photo 5.2-3
Landslide on Autauga County Road 47 in 2005

Landslides are not uncommon in interbedded unconsolidated sands and clays of the Tuscaloosa Group of the Gulf Coastal Plain. One example is a landslide near Coker that recently became active again during heavy rains. This slide is still threatening an adjacent house built on top of a hill (**Photo 5.2-4**).

Photo 5.2-4
Landslide threatening house on a hill near Coker in the Coker Formation in 2004

Currently, in the City of Spanish Fort, Baldwin County, the bluffs located along the eastern shore of the Mobile Bay are slowly receding due to wave erosion causing a substantial threat to a number of homes along the bluff. The City and State have applied for funds to stabilize the bluff hence reducing future property and infrastructure damage that could be caused by a landslide in this area.

Probability of Landslides in Alabama

Figure 5.2-8 is a landslide incidence/susceptibility map obtained from the Geological Survey of Alabama in April 2007. This map was prepared by classifying geographic areas as having high, medium, and low susceptibility and/or incidence to landsliding. Landslide incidence is defined as the number of landslides that have occurred in a given geographic area; whereas susceptibility to landsliding is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. Generally, it can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past.

The map units are split into three incidence categories according to the percentage of the area affected by landslide. High incidence means greater than 15 percent of a given area has been involved in landsliding; medium incidence means that 1.5 to 15 percent of an area has been involved; and low incidence means that less than 1.5 percent of an area has been involved. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding. Susceptibility is not indicated where it is the same as or lower than incidence. Because **Figure 5.2-8** was prepared at a small scale using limited landslide and climate information, it is not intended for local planning or actual site election.

Landslide probability is highly site-specific, and cannot be accurately characterized on a statewide basis, except in the most general sense. As described above, landslides are also influenced by the weather and other physical phenomena such as seismic activity. Given that landslides are a fairly widespread and common occurrence in the State, it is reasonable to assume that there will be numerous landslides in the State every year. The qualitative probability is rated Low in **Section 5.3** because the overall area in the state that is likely to be affected by landslides is relatively small (not the area that is considered "high incidence" in the **Figure 5.2-8**). The rating is intended only for general comparison to other hazards that are being considered in this stage of the planning process.

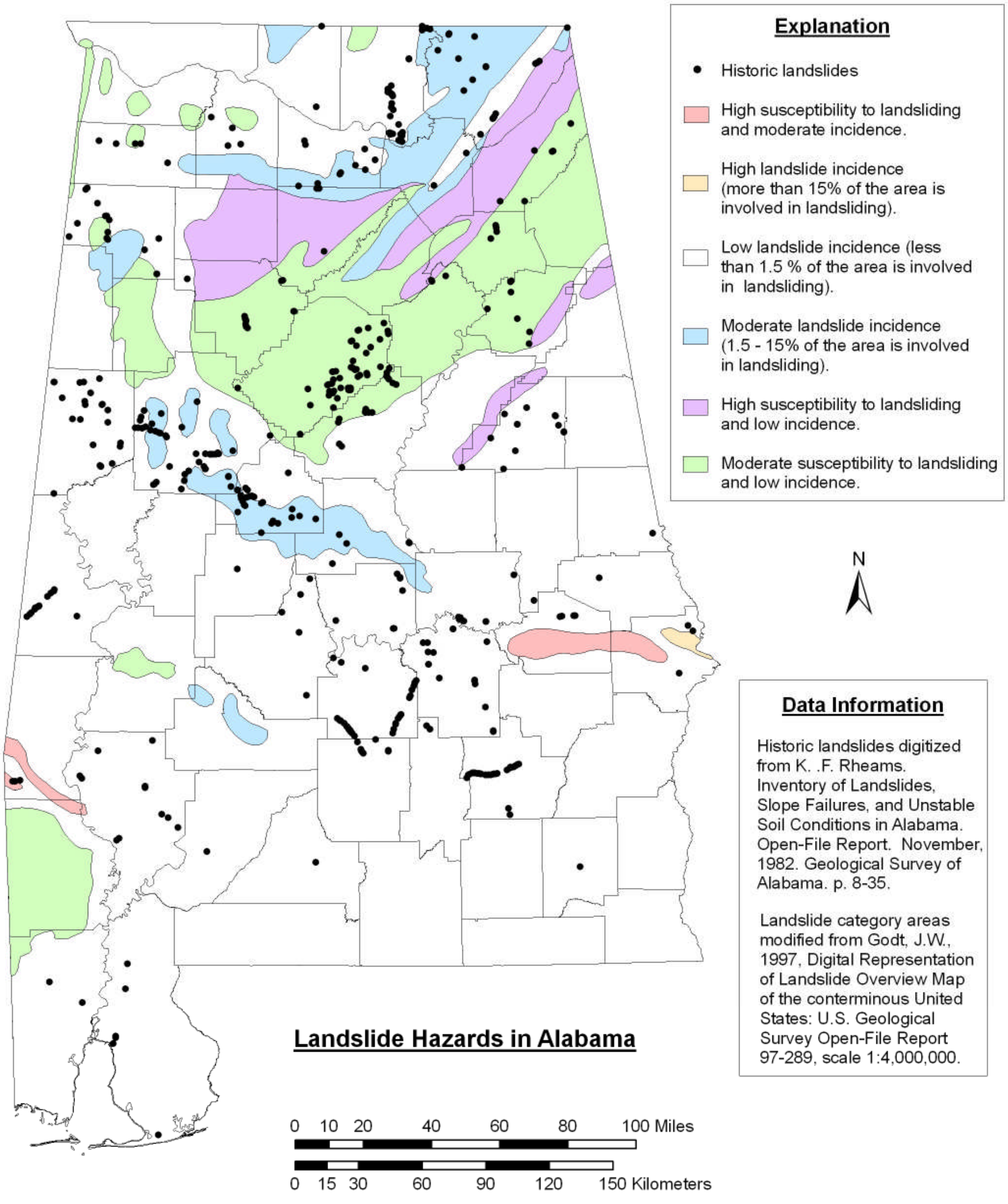


Figure 5.2-8
Updated Statewide Landslide Incidence and Susceptibility
Sources: Geological Survey of Alabama

5.2.5 Sinkholes and Land Subsidence

Nature of the Hazard in Alabama

In Alabama, sinkholes are common where the rock below the land surface is limestone, dolomite, or salt that can naturally be dissolved by ground water. As the rock dissolves, cavities and caverns develop underground. Sinkholes may be dramatic if the land stays intact for some time until the underground spaces just get too big and a sudden collapse of the land surface occurs.

Sinkholes and subsidence are also common in those areas of the state underlain by old abandoned coal and iron mines. Pillars left for roof support in the mines generally deteriorate over time and eventually collapse, removing roof support. This is particularly a problem where mines underlie more recently developed residential areas and roads.

Major parts of the state are characterized by carbonate rocks, such as limestone and dolomite, which are vulnerable to solution in the humid southern climate. Areas in Alabama characterized by the presence of subsurface cavities, sinkholes, and underground drainage are called “karst terrains.” It is these karst areas that are most susceptible to sinkhole development and subsidence. Figure 5.2-9, at the end of this section, illustrates the areas with outcrops of carbonate rocks susceptible to subsidence and the areas of active sinkholes and subsidence.

A review of available local hazard mitigation plans revealed that 43 out of 66 counties identified sinkholes and land subsidence as hazards to which they are vulnerable.

Sinkhole and Land Subsidence History in Alabama

Sinkholes are becoming an increasing problem in Alabama as the population encroaches on scenic rural valleys developed in limestone in the Alabama Valley and Ridge province, and as large metropolitan areas in the Appalachian Plateaus of north Alabama continue to expand. Within recent years, there have been many sinkholes reported throughout the state. Recent periods of drought have aggravated the problem. Some of the more recent sinkholes affecting buildings and infrastructure have occurred in or near Sylacauga, Opelika, Valley Head, Huntsville, Auburn, Phenix City, Montevallo, Alabaster, Gadsden (**Photo 5.2-5**), Birmingham (**Photo 5.2-6**), Tuskegee, and Trussville.

Photo 5.2-5
Sinkhole that developed overnight in Gadsden, Alabama, in 2002
The sink swallowed a Volkswagen that was parked in the yard.

Photo 5.2-6
Filling one of several sinkholes that have developed in the
Burlington Railroad yard in Birmingham, Alabama

A large sinkhole developed near Calera in Shelby County in a matter of seconds in December 1972. The sink is about 425 feet long, 350 feet wide and 150 feet deep. The sinkhole, called the "December Giant" or the "Golly Hole," is the largest on record for the United States. This sinkhole occurred during a drought when the water table was much lower than normal. It was found by hunters two days after someone reported hearing a roaring noise, trees breaking and his house shaking.

In 1990, a sinkhole was formed by raveling in Hale County. An oil and gas drill rig had reached a depth of 755 feet when the drilling fluid was lost in the hole. In a period of 2 hours unconsolidated sediments overlying karst Knox Group carbonates had moved downward into subsurface cavities in the Knox, carrying the drill rig downward with them (**Photo 5.2-7**). The weight of the fluids in the adjacent mud pit facilitated the rapid downward movement of the sediments. Another well was drilled successfully across the road to a total depth of 12,000 feet.

Photo 5.2-7
Sinkhole that swallowed a drilling rig in Hale County, Alabama in 1990

Trussville provides a prime example of the impact sinkholes can have on a growing community where land and ground water are both in great demand. Sinkholes first formed beneath and around the Trussville Middle School, forcing closure and rebuilding of the school at another site. Sinkholes continued to develop in a nearby park and neighborhood (**Photo 5.2-8**) and emptied a pond. Damage has been estimated to be millions of dollars.

Photo 5.2-8
One of many sinkholes that developed near a house in Trussville, Alabama, in 2001
This sink formed under the corner of a house.

Probability of Sinkholes and Land Subsidence in Alabama

While sinkholes are not uncommon in the State of Alabama, the probability of future occurrences cannot be characterized on a statewide basis, except in the most general sense. It is likely that sinkhole occurrences will remain relatively constant, although as noted above, weather and other physical phenomena influence probability. The qualitative probability is rated low in **Section 5.3**, because the overall area of the State that is affected every year is low and impacts are highly site specific and localized. This rating is intended only for general comparison to other hazards that are being considered in this state of the planning process. **Figure 5.2-9**, provided by GSA in April 2007, shows karst areas of the State that are more likely to experience to sinkholes and subsidence.

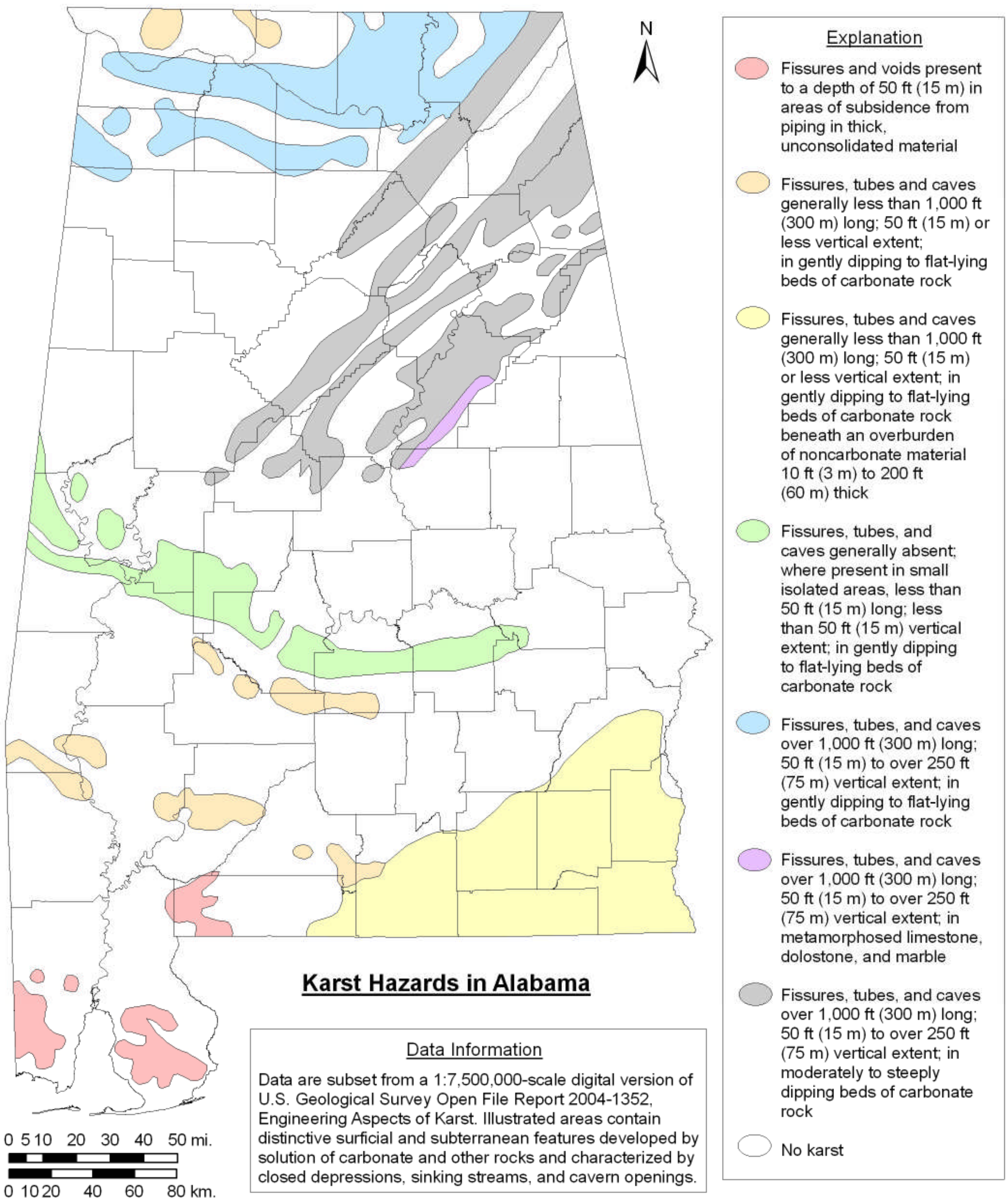


Figure 5.2-9
Karst Areas in State Most Likely to Experience Sinkholes and Subsidence
Source: Geological Survey of Alabama

5.2.6 Earthquakes

Nature of the Hazard in Alabama

The State of Alabama is currently working to better define its risks to earthquakes. GSA, in conjunction with AEMA, is currently developing a statewide basement fault map and a statewide soil amplification/liquefaction maps. These will be incorporated into the plan when complete. These activities indicate that earthquakes are a high-priority hazard for the State of Alabama and future updates will include more detailed information.

Earthquakes are fairly common in the eastern half of the United States and are not uncommon in Alabama. Three zones of frequent earthquake activity affecting Alabama are the New Madrid Seismic Zone (NMSZ), the Southern Appalachian Seismic Zone (SASZ) (also called the Eastern Tennessee Seismic Zone), and the South Carolina Seismic Zone (SCSZ). The NMSZ lies within the central Mississippi Valley, extending from northeast Arkansas through southeast Missouri, western Tennessee, and western Kentucky, to southern Illinois. The SASZ extends from near Roanoke in southwestern Virginia southwestward to central Alabama. Considered a zone of moderate risk, the SASZ includes the Appalachian Mountains. Most of the earthquakes felt in Alabama are centered in the SASZ. The hypocenters of earthquakes in this zone are on deeply buried faults. The SCSZ is centered near Charleston South Carolina and encompasses nearly the whole State. These three zones can be easily seen in **Figure 5.2-10**, below.

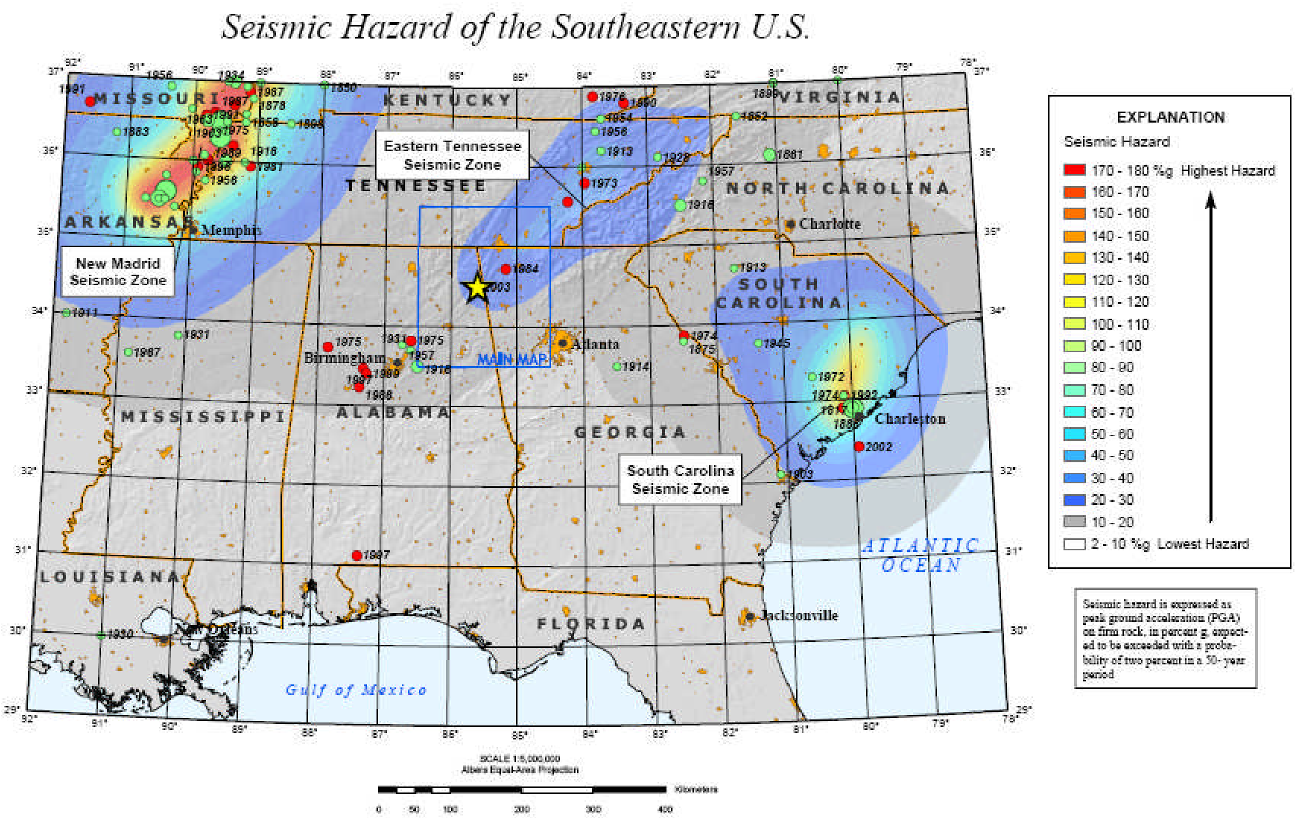


Figure 5.2-10
Seismic Zones of the Southeastern United States
Source: United States Geological Survey

A major earthquake in Alabama could result in great loss of life and property damage in the billions of dollars. Adding to the danger is the fact that structures in the area were not built to withstand earthquake shaking. Construction of many buildings on steep slopes susceptible to landslides and in karst terrains susceptible to sinkholes will be a major contributing factor to damage from future earthquakes in the northern part of the state.

Another previously unrecognized seismic zone (herein referred to as the Bahamas Seismic Zone or the BSZ) occurs in southwest Alabama and is related to the Bahamas fault zone. Several earthquakes have occurred along this zone in recent years, including a 4.9 magnitude earthquake in 1997.

Earthquakes occurring in these seismic zones all have the potential to affect different areas in the State of Alabama.

A review of available local hazard mitigation plans revealed that 53 out of 66 counties identified earthquakes as a hazard to which they are vulnerable.

Earthquake History in Alabama

Figure 5.2-11 shows the location of magnitudes of all known earthquakes occurring in Alabama from 1886 thru June 2007.

Historical records indicate the first earthquake reported in Alabama shook residents of Sumter and Marengo Counties in the western part of the State on February 4, 1886. A similar shock occurred nine days later, on February 13. Both were reportedly felt at communities along the Tombigee River, but caused no damage.

On August 13, 1886, the southeastern United States was strongly shaken by a large magnitude 7.3 earthquake centered at Charleston, South Carolina, in the SCSZ. The earthquake leveled almost every building in the Charleston area and caused 60 deaths. The earthquake was felt for 750 miles from the epicenter, and several areas in Alabama recorded damage.

On October 18, 1916, a strong earthquake occurred on an unnamed fault east of Birmingham in Shelby County. This was the strongest earthquake ever to occur in Alabama. Near the epicenter, chimneys were knocked down, windows broken, and frame buildings “badly shaken.” It was noted by residents in seven states and affected 100,000 square miles. The epicenter is in an area that was rural at the time of the earthquake. Today this area is highly populated and many structures are situated on steep hillsides susceptible to landslides. Another earthquake of the same magnitude in this area would cause considerable damage today.

Another tremor that damaged the Birmingham area occurred on April 23, 1957. The earthquake shook residents in southern Tennessee, western Georgia, and most of northern and central Alabama. Earthquake records for that year state: “Felt by, awakened, and alarmed many. Minor damage to several chimneys; one report of cement steps cracked in two; and several small cracks in walls. Table-top items tumbled to the floor.”

On August 12, 1959, a shock was felt in the Huntsville area. Though felt over a small area of southern Tennessee and northern Alabama, it shook bricks from chimneys at Hazel Green; damaged one chimney and a newly constructed concrete block building at Meridianville; violently shook the buildings at New Sharon, knocking canned goods from shelves and sending frightened residents fleeing from their homes; and cracked plaster and knocked groceries from shelves at Huntsville.

August 29, 1975, a 4.4M (Intensity VI) earthquake occurred at Palmerdale, Alabama. The earthquake cracked a sheetrock ceiling and shifted lamps on tables at Palmerdale, north of Birmingham. It caused slight damage at Watson, where furniture was displaced slightly. The quake was also felt in southern Tennessee.

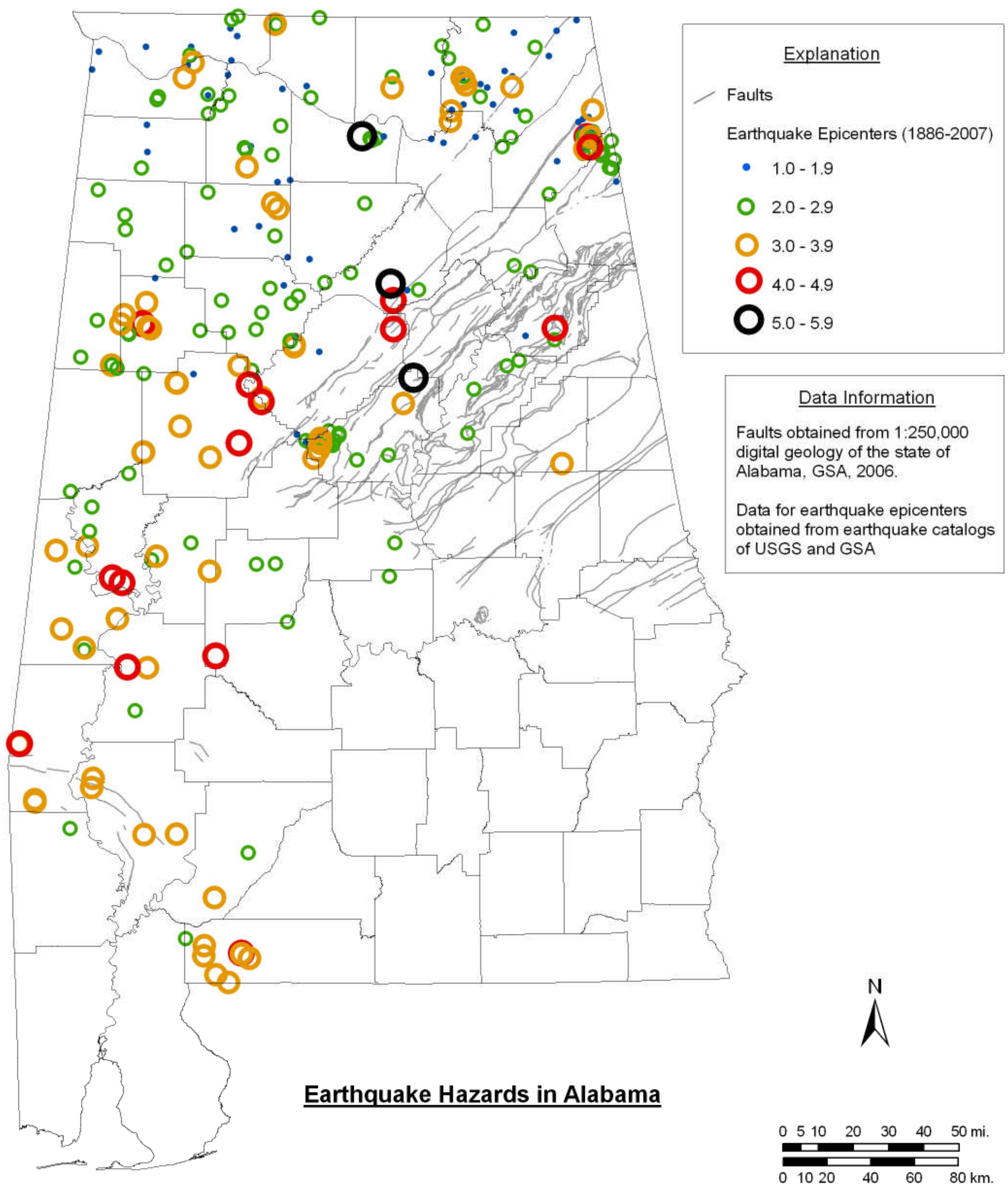


Figure 5.2-11
Historical Earthquakes of Alabama (1886-2007)
Source: Geological Survey of Alabama, 2007

On August 20, 1989, a 3.9M (Intensity VI) earthquake occurred near Littleville, Alabama. A Colbert County official reported that south of Florence, between Littleville and Russellville, a basement wall collapsed beneath a house. Only slight damage was reported north of the epicenter at Florence, where windows were cracked and hairline cracks formed in plaster. The earthquake was also felt in Lauderdale, Lawrence, and Morgan Counties in northwest Alabama.

On Friday morning October 24, 1997, at 3:35 AM, a significant earthquake awoke a large number of people in Escambia County, Alabama, and adjacent areas. Soon it became apparent there had been an earthquake that affected all of southwest Alabama and parts of Mississippi and Florida (**Figure 5.2-12**). The epicenter of the earthquake was east of the town of Atmore. The moment magnitude, approximately equivalent to the Richter scale magnitude, was reported to be 4.9, the largest earthquake to be recorded by seismograph in Alabama at that time and the largest in the southeast in the last 30 years. Aftershocks were felt on October 26 and on October 28, 1997, and on January 26, 1998. A foreshock on May 4, 1997, had a magnitude of 3.1. This earthquake was in the BSZ. Fortunately, the epicenter was in a rural area, limiting the damage. Intensities of VII were reported at the epicenter. Other measured intensities included: VI near Brewton, Alabama; VI at Brewton, Canoe and Lambeth; V at Atmore, Flomaton, Frisco City and Huxford; IV at Perdido and Robinsonville; III at Butler, Demopolis, Goodway, Mobile and Uriah; V at Century, Florida; IV at McDavid, Pensacola and Walnut Hill; III at Milton, Florida; and IV at Leakesville, Mississippi. The earthquake was also felt at Megargel; Elgin AFB, Florida; Biloxi and Gulfport, Mississippi.

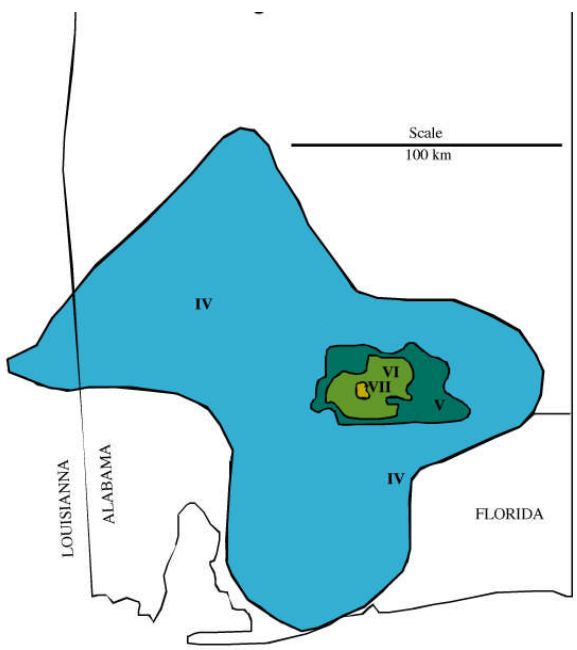
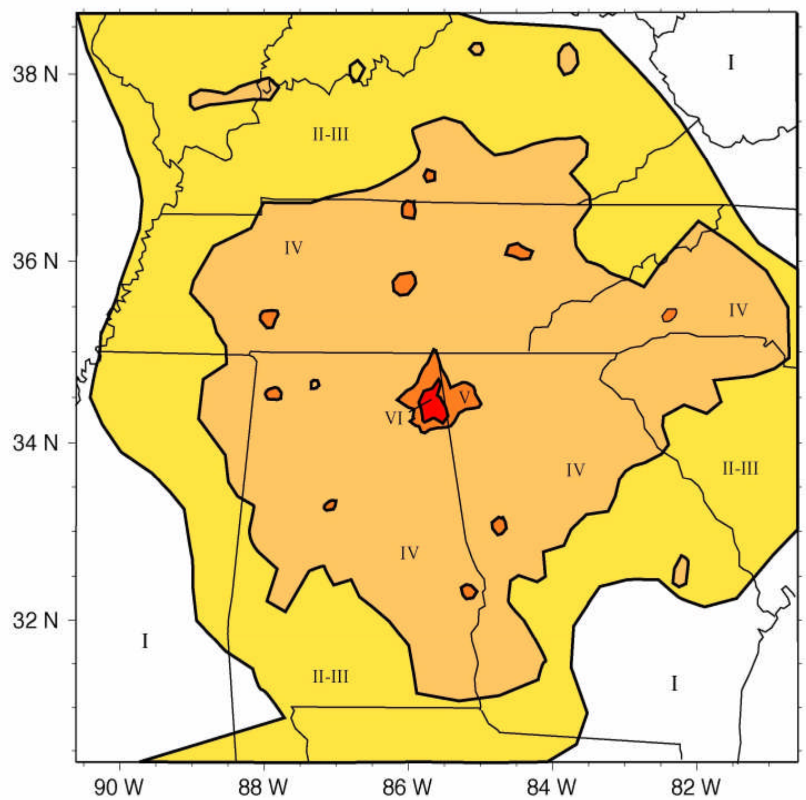


Figure 5.2-12
Intensity Map for the Escambia County Earthquake Of October 24, 1997
Source: Geological Survey of Alabama, 2004

On April 29, 2003, at 3:59 AM a strong earthquake with a magnitude of 4.9 magnitude (Richter) occurred in DeKalb County, Alabama, just east of DeSoto State Park and 10 miles ENE of Fort Payne, Alabama. The earthquake was felt in 11 states (**Figure 5.2-13**). Pictures moved on walls, items fell off shelves; a trailer was shaken off its foundation. Many people were shaken out of their beds following the thunderous rumble and subsequent strong shaking of the ground. Some reported the trembling lasted less than 10 seconds, while some areas reported shaking up to 45 seconds. At least 40 homes in DeKalb County were damaged. The area hardest hit was around Hammondville, Mentone, and Valley Head. The damage included broken windows and bricks, cracked walls and foundations. Several bricks on a chimney at Moonlake Elementary School at Mentone came loose and fell on the building's roof. The school, built in the 1930s, is located atop Lookout Mountain near the earthquake's epicenter. A few miles away at the foot of the mountain, the Mentone town of Valley Head had to switch to its reserve water supply and use water from neighboring towns after its water pumps automatically shut down. Vibration from the earthquake disturbed the sediment in a natural spring, the town's main water supply, and muddied the water. The quake apparently broke a berm on a 4.5 acre pond in Lawrence County, Alabama, near Courtland, dumping water and fish in a field and across a highway. As a result of the earthquake, a 29 foot wide sinkhole developed in Ordovician dolomites northwest of Fort Payne.



INTENSITY	I	II-III	IV	V	VI
SHAKING	Not felt	Weak	Light	Moderate	Strong
DAMAGE	none	none	none	Very light	Light

Figure 5.2-13
Intensity Map for the April 29, 2003 Earthquake Near Fort Payne, Alabama
Source: Geological Survey of Alabama, 2004

On the morning of March 22, 2005, a weak earthquake with a magnitude of 3.3 (Richter) occurred in Clarke County, Alabama near Coffeeville. Many people were awoken by the noise and shaking, but no damage was reported. This area of the State sits on the BSZ discussed earlier in this section.

Probability of Earthquakes in Alabama

According to the Center for Earthquake Research and Information at the University of Memphis, there is a 40 to 60 percent probability of a "damaging" NMSZ earthquake in the magnitude 6.0 to 6.3 range in the next 15 years and an 86 to 97 percent probability of a similar size quake in the next 50 years. In addition, there is a 19 to 29 percent probability of a "great earthquake" in the magnitude 7.6 range. Portions of north Alabama are susceptible to a New Madrid earthquake. Most of the risk in this area would be to non-structural items (light fixtures and bookshelves falling, etc.), but structural damages to weaker buildings and utilities (pipelines) could also occur. Damage in northern Alabama also could result from a large earthquake in the SASZ. Most of the earthquakes in the SASZ have had magnitudes ranging between 2 and 3, but one of magnitude 5.8 has been recorded in Virginia. The potential exists for widespread damage and disruption in north Alabama from another earthquake in the SCSZ, particularly where utilities and public works are concerned.

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as peak ground acceleration (PGA), over a specified period of years. The magnitudes of earthquakes are generally measured using the Richter scale, as discussed in Appendix T. The severity of earthquakes is site specific, and is influenced by proximity to the earthquake epicenter and soil type, among other factors. Although earthquakes are relatively common in Alabama, they are predominantly low magnitude events so the qualitative probability in **Section 5.3** is low. However, there is growing concern that a high magnitude event is inevitable and earthquakes are becoming a much larger concern to the State of Alabama. GSA is currently working to better define seismic hazards and impacts throughout the State. **Figure 5.2-14** shows the Percent Ground Acceleration (PGA) with two percent 50 year exceedance probability.

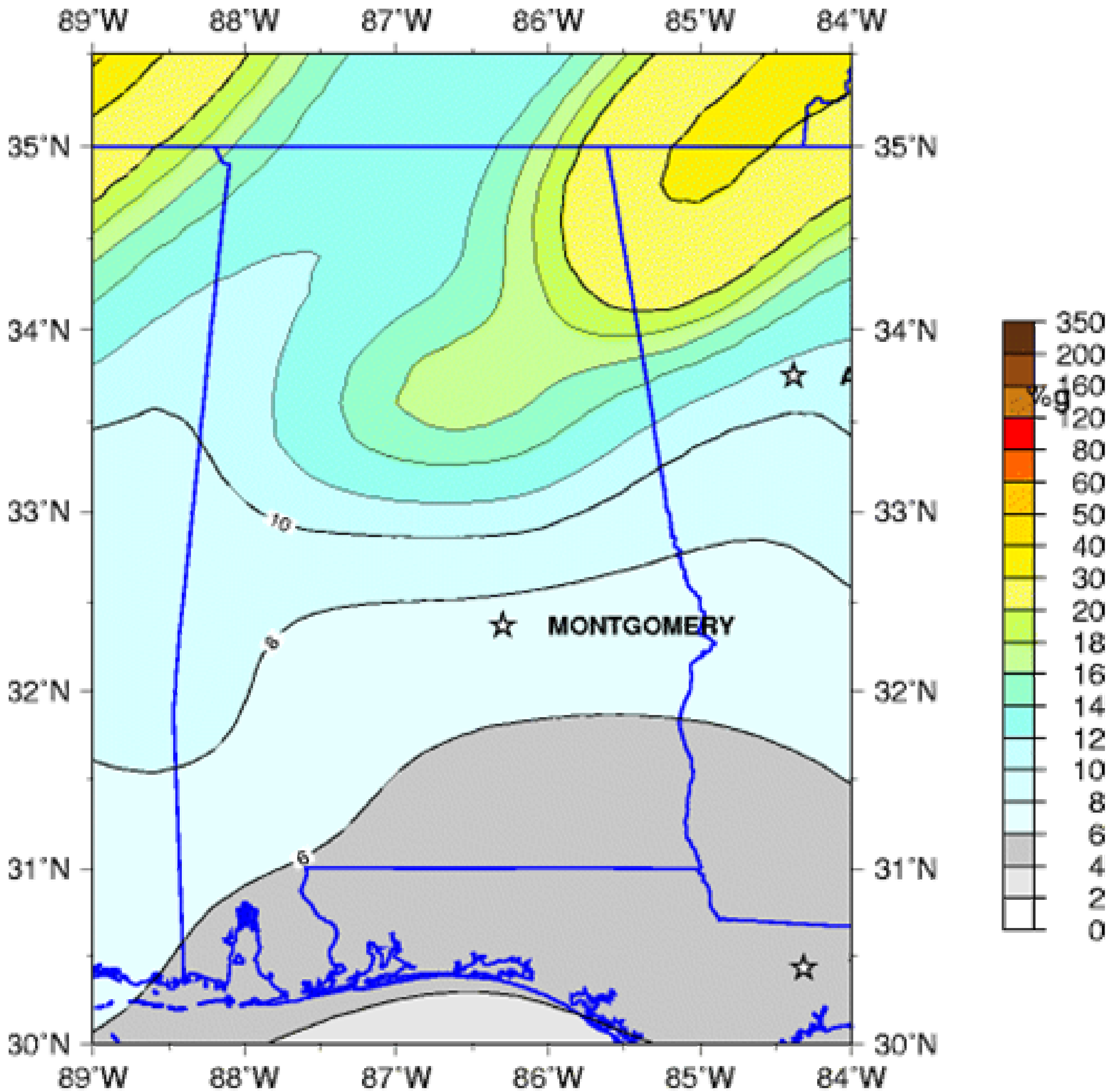


Figure 5.2-14
Peak Ground Acceleration (%g)
With 2% Probability of Exceedance in
50 Years (Updated)
Source: United States Geological Survey, 2007

5.2.7 Drought

Nature of the Hazard in Alabama

Drought is a natural event that, unlike floods or tornados, does not occur in a violent burst but gradually happens; furthermore, the duration and extent of drought conditions are unknown because rainfall is unpredictable in amount, duration and location.

The Draft Alabama Drought Management Plan (DMP), developed by the Alabama Department of Economic and Community Affairs – Office of Water Resources (ADECA-OWR), defines drought in terms of several indices that describe the relative amounts of surface water flow, groundwater levels, and recent precipitation as compared to localized norms. Because drought is defined in relative terms, it can be stated that all areas of the State are susceptible drought. Further discussion of the Draft Alabama Drought Management Plan is included in **Section 4.3**. In addition, actions from the DMP have been incorporated into **Section 6.7**.

When drought occurs in Alabama, the social, economic, and environmental impacts have the potential to be severe and widespread. A few of these impacts are listed below:

- Damage to livestock and crops;
- Increase local vulnerabilities to sinkholes and wildfire;
- Create water usage conflicts;
- Speed up coastal erosion;
- Damage fisheries; and
- Inflate energy prices due to loss of hydro-power.

A review of available local hazard mitigation plans revealed that 59 out of 66 counties identified drought as a hazard to which they are vulnerable.

Drought History in Alabama

According to FEMA, Alabama has had one federal drought disaster declared in 1977. According to the NCDC, there were 15 drought events from 1998 through 2005. However, further investigation reveals that most of these were simply dry periods without substantial rainfall. No damages, deaths, or injuries were reported.

More recently, according to NOAA, much of Alabama experienced significant drought conditions during the summer of 2006. An extended period of low rainfall led to the development of severe drought conditions throughout Central Alabama during the month of July. The southernmost areas in this region (along and south of US Route 80) were experiencing extreme drought conditions by the end of the month. Conditions continued through August and the first half of September when several bouts of significant precipitation fell to improve conditions throughout the State by the morning of September 19, 2006. Agricultural and hydrologic impacts were felt. Summer crops were adversely impacted and water restriction regulations were put into effect in many cities. In total, 39 counties experienced at least severe drought conditions, while 11 of those experienced extreme drought conditions.

The following counties experienced severe drought conditions: Autauga, Bibb, Blount, Calhoun, Chambers, Cherokee, Chilton, Clay, Cleburne, Coosa, Elmore, Etowah, Fayette, Greene, Hale, Jefferson, Lamar, Lee, Marion, Pickens, Randolph, Shelby, St. Clair, Talladega, Tallapoosa, Tuscaloosa, Walker, and Winston.

The following counties experienced extreme conditions: Barbour, Bullock, Dallas, Lowndes, Macon, Marengo, Montgomery, Perry, Pike, Russell, and Sumter.

As of 2006, all of the State of Alabama is experiencing between moderate and severe drought conditions; however, information regarding the impacts and duration of this drought are not available at this time. **Figure 5.2-15**, below, was obtained from the Office of the State Climatologist and shows drought conditions throughout the State during the week of May 26, 2007 in terms of the Palmer Drought Index which is described in **Appendix H**. It must be noted that this map is updated on a weekly basis and can be found on the website of the Office of the State Climatologist.

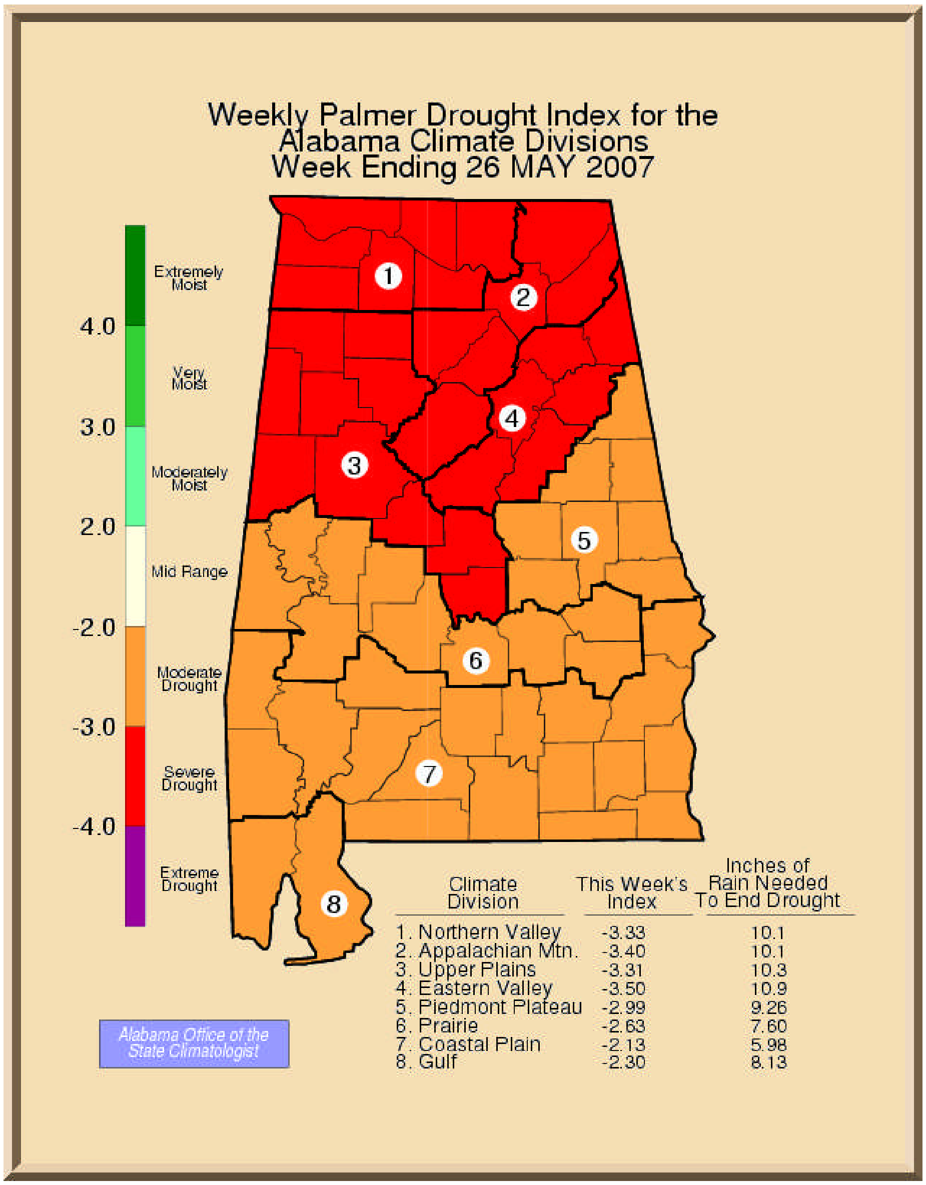


Figure 5.2-15 Palmer Drought Severity Index Map for State of Alabama Week of May 26, 2007
Source: Office of the State Climatologist

Probability of Drought in Alabama

The future incidence of drought is highly unpredictable, conditions may be localized or widespread, and not much historical data is available making it difficult to determine the future probability of drought conditions with any accuracy. The qualitative probability rating for drought in **Section 5.3** is medium.

5.2.8 Hail

Nature of the Hazard in Alabama

Hailstorms occur throughout the State of Alabama and most frequently during the late spring and early summer, when the jet stream moves northward across the Great Plains. During this period, extreme temperature changes occur from the surface up to the jet stream, resulting in the strong updrafts required for hail formation. As explained below, it is rare that a hailstorm in Alabama causes significant damages.

A review of available local hazard mitigation plans revealed that 56 out of 66 counties identified hail as a hazard to which they are vulnerable.

Hail History in Alabama

From 1990 to 2004, hail storm events caused approximately $14.5 million in damages in Alabama. This damage was caused by severe hail storm events that had hail with a diameter of 1.5 inches or greater. No deaths or injuries were reported due to hail storms.

On May 15, 1995, hail up to 4.5 inches was reported in the area from southern Cullman to Hanceville. Numerous cars sustained damage in the hail including one Chevrolet dealership where every car sustained damage. Approximately $700,000 in property damage was caused by the hail storm event.

In May 2003, hail (between 1.75 and 2.5 inches) fell between Chatom and Wagarville. Numerous automobiles and roofs were damaged by the large hail. Two automobile dealerships in Chatom sustained major damage to their automobile inventory. This hail storm event caused approximately $1.4 million in property damage.

On April 25, 2003, a large swath of golf ball size hail affected locations including Jones, Autaugaville, Booth, Independence, and Prattville. The largest hail observed was softball size. Numerous automobiles and homes were damaged by the hail. The storm started off by producing a weak tornado that moved through Greene County and crossed the Black Warrior River ending just inside Hale County. The storm continued strengthening and produced a swath of wind and hail damage along its path. Significant wind and hail damage occurred from Autaugaville to Prattville to Montgomery. This storm caused $2.5 million in property damage.

From 2004 to 2006, the State of Alabama experienced hail in at least one location in the State on 111 days. Of the 111 events, 76 caused no reported damages. The remaining 35 events caused $2.1 million worth of damage throughout the state. No deaths or injuries were reported due to hailstorms.

On March 26 and 27, 2005, a thunderstorm system moving across the State produced hailstones between 1.5 and 2.5” in diameter in the southwest part of the state. Damages to homes and vehicles amounted to approximately $414,000.

On April 7, 2006, a thunderstorm system moved across the State producing hailstones up to 2.5 inches in diameter in the northwest part of state. Damages to homes and vehicles amounted to approximately $557,000.

Hailstorm Probability in Alabama

As discussed above, hailstorms occur in some form or fashion on a very regular basis in Alabama. Between 1955 and 2006, Alabama has experienced 1,021 days in which a hailstorm was reported in at least one location in the State. Therefore, it can be reasonably stated that, over the long-term, hail will affect at least some part of the State on an average of 20 days per year, or once every 18 days.

The annual probability of hail occurring somewhere in the State is clearly quite high. However, the site-specific incidence of hail is considered low because of the localized nature of the hazard. The qualitative probability rating for Hail in **Section 5.3** is medium. **Figure 5.2-16** shows the average number of hailstorms by county from 1955 through 2006.

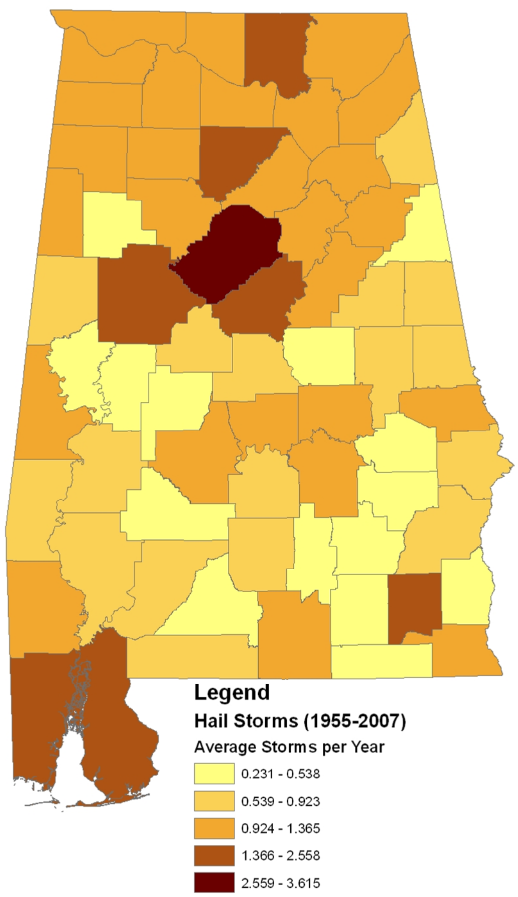


Figure 5.2-16
Average Number of Hailstorms per Year

5.2.9 Wildfire

Nature of the Hazard in Alabama

Approximately 94 percent of Alabama's forestlands are privately owned; therefore the vast majority of wildland fires occur on privately owned lands. Additionally, the majority of the fires occur in areas where homes or structures are endangered. These areas are known as the wildland urban interface and are defined as areas where development meets wildland vegetation, both of which provide fuel for fires. The wildland urban interface areas have increased significantly throughout the U.S. and Alabama, and now face the risk of major losses from wildfires. In Alabama, most wildland urban interface areas are considered "intermixed." Instead of having large forest areas surrounding an isolated town, Alabama contains many scattered homes and farms spread across the forest areas. Based on an initial analysis by the Alabama Forestry Commission, there are 1,350 potential wildland urban interface communities at risk of wildfire damage within Alabama.

The following two factors contribute significantly to wildfire behavior in Alabama:

1. **Fuel:** The type of fuel and the fuel loading (measured in tons of vegetative matter per acre) have a direct impact on fire behavior. Fuel types vary from light fuels (grass) to moderate fuels (Southern Rough) to heavy fuels (slash). The type of fuel and the fuel load determines the potential intensity of the wildfire and how much effort must be expended to contain and control it.

2. **Weather:** The most variable factor affecting wildfire behavior is weather. Important weather variables are precipitation, humidity, and wind. Weather events ranging in scale from localized thunderstorms to large cold fronts can have major effects on wildfire occurrence and behavior. Extreme weather, such as extended drought and low humidity can lead to extreme wildfire activity.

In addition to affecting people, wildfires may severely impact livestock. Since 2000, wildfires destroyed 6,564 large hay bales, inflicting a severe economic impact on farmers. The forest resources of Alabama feed one of the main industries of the state. Timber loss to fire creates an economic loss to both the private landowner and the State's economy. Wildfires in Alabama generally are moderate in intensity, resulting in destruction of undergrowth and some timber. With Alabama's long growing season, the soil surface layer of the forest recovers quickly, minimizing erosion and water quality impacts. The entire state is vulnerable to wildfires as can be seen in **Figure 5.2-17**.

A review of available local hazard mitigation plans revealed that 57 out of 66 counties identified wildfires as a hazard to which they are vulnerable.

Wildfire History in Alabama

The frequency and severity of wildfires is dependent on weather and on human activity. Nearly all wildfires in Alabama are human caused (only 3 percent are caused by lightning), with arson and careless debris burning being the major causes of wildfires. If not promptly controlled, wildfires may grow into an emergency or disaster. During a severe fire situation in 1999-2000, eight wildfires in Alabama were declared Fire Disaster Emergencies by FEMA. Even small fires can threaten lives, damage forest resources and destroy structures. Each year, wildfires threaten an average of 1,600 homes and structures, destroying around 115 and damaging about 44.

Table 5.2-5 shows the number of fires and acres burned during the period 1995 to2006, as recorded by the Alabama Forestry Commission. Alabama had a total of 46,417 fires during this 12 year period, affecting a total of 536,523 acres.

Table 5.2-5
Wildfires in Alabama 1995-2006 (Updated)

County	Total # of Fires	Average # of Fires	Total Acres Burned	Average Acres Burned	Average Fire Size
Autauga	834	69.5	4,527.3	377.3	5.4
Baldwin	2797	233.1	51,275.5	4,273.0	18.3
Barbour	374	31.2	4,089.1	340.8	10.9
Bibb	719	59.9	5,203.6	433.6	7.2
Blount	583	48.6	4,492.0	374.3	7.7
Bullock	461	38.4	6,887.3	573.9	14.9
Butler	630	52.5	4,263.0	355.3	6.8
Calhoun	703	58.6	8,295.8	691.3	11.8
Chambers	504	42.0	3,032.2	252.7	6.0
Cherokee	1882	156.8	28,666.7	2,388.9	15.2
Chilton	1078	89.8	5,659.1	471.6	5.2
Choctaw	419	34.9	4,467.3	372.3	10.7
Clarke	463	38.6	2,363.7	197.0	5.1
Clay	666	55.5	8,472.4	706.0	12.7
Cleburne	1336	111.3	28,978.1	2,414.8	21.7
Coffee	218	18.2	10,35.7	86.3	4.8
Colbert	643	53.6	4,413.9	367.8	6.9
Conecuh	928	77.3	9,276.7	773.1	10.0
Coosa	500	41.7	5,845.8	487.1	11.7
Covington	516	43.0	4,583.1	381.9	8.9
Crenshaw	347	28.9	1,540.4	128.4	4.4
Cullman	413	34.4	3,767.9	314.0	9.1
Dale	150	12.5	764.1	63.7	5.1
Dallas	460	38.3	3,588.3	299.0	7.8
DeKalb	607	50.6	9,216.7	768.1	15.2
Elmore	1251	104.3	5,563.7	463.6	4.4
Escambia	1184	98.7	13,351.7	1,112.6	11.3
Etowah	530	44.2	6,401.5	533.5	12.1
Fayette	394	32.8	3,993.6	332.8	10.1
Franklin	528	44.0	7,959.2	663.3	15.1
Geneva	188	15.7	1,005.3	83.8	5.3
Greene	353	29.4	1,335.4	111.3	3.8
Hale	310	25.8	1,112.3	92.7	3.6
Henry	199	16.6	1,133.8	94.5	5.7
Houston	157	13.1	987.1	82.3	6.3
Jackson	468	39.0	10,459.2	871.6	22.3

Table 5.2-5
Wildfires in Alabama 1995-2006 (Updated)

County	Total # of Fires	Average # of Fires	Total Acres Burned	Average Acres Burned	Average Fire Size
Jefferson	1408	117.3	14,368.4	1,197.4	10.2
Lamar	318	26.5	2,818.6	234.9	8.9
Lauderdale	980	81.7	6,354.8	529.6	6.5
Lawrence	522	43.5	6,007.8	500.7	11.5
Lee	277	23.1	1,627.3	135.6	5.9
Limestone	175	14.6	1,569.2	130.8	9.0
Lowndes	467	38.9	3,642.5	303.5	7.8
Macon	930	77.5	15,290.9	1,274.2	16.4
Madison	291	24.3	1,663.1	138.6	5.7
Marengo	316	26.3	2,659.0	221.6	8.4
Marion	768	64.0	6,516.6	543.1	8.5
Marshall	197	16.4	2,744.6	228.7	13.9
Mobile	3499	291.6	58,120.7	4,843.4	16.6
Monroe	774	64.5	5,350.2	445.9	6.9
Montgomery	214	17.8	1,586.6	132.2	7.4
Morgan	248	20.7	2,192.0	182.7	8.8
Perry	462	38.5	2,900.3	241.7	6.3
Pickens	411	34.3	2,851.4	237.6	6.9
Pike	229	19.1	1,426.2	118.8	6.2
Randolph	577	48.1	3,832.1	319.3	6.6
Russell	718	59.8	8,337.1	694.8	11.6
Shelby	974	81.2	13,205.5	1,100.5	13.6
St. Clair	893	74.4	10,165.9	847.2	11.4
Sumter	173	14.4	2,073.1	172.8	12.0
Talladega	1802	150.2	32,975.4	2,748.0	18.3
Tallapoosa	674	56.2	4,277.1	356.4	6.3
Tuscaloosa	604	50.3	8,941.9	745.2	14.8
Walker	1353	112.8	13,118.6	1,093.2	9.7
Washington	1412	117.7	24,719.5	2,060.0	17.5
Wilcox	460	38.3	2,498.7	208.2	5.4
Winston	498	41.5	4,681.0	390.1	9.4
Totals	**46,417**	**3,868.1**	**536,523.7**	**44,710.3**	**11.6**

Sources: Alabama Forestry Commission

Probability of Wildfires in Alabama

Wildfires are an ongoing threat to both rural Alabama and wild land urban interface communities at risk. Based on the 12 year data available in **Table 5.2-5,** above, it can be deduced that the State experiences 3,868 fires annually that can affect 44,710 acres every year. As with most natural hazards, wildfires are strongly influenced by weather phenomena, although their risk and impacts are also related to other factors such as the number of structures that are near forested areas, and so forth. Wildfire probability can be expected to remain relatively constant over the long run, assuming that weather patterns do not change significantly. The qualitative probability rating is **Section 5.3** is medium. In addition, **Figures 5.2-17** and **5.2-18** show the total number of acres burned by wildfire in the 12-year period by county and the annual number of fires per square mile by county, respectively.

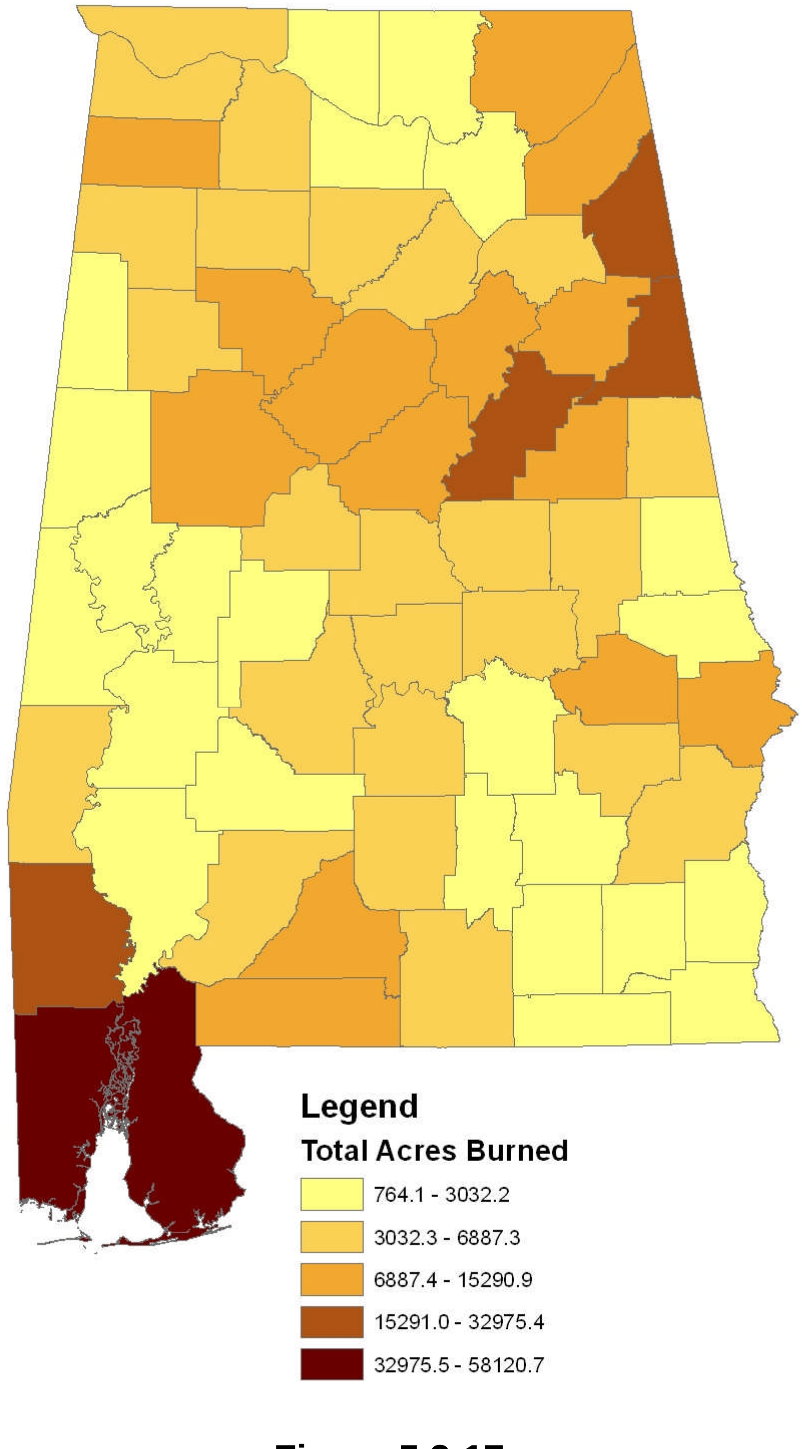


Figure 5.2-17
Total Acres Burned by Wildfire 1995-2006
Source: Alabama Forestry Commission

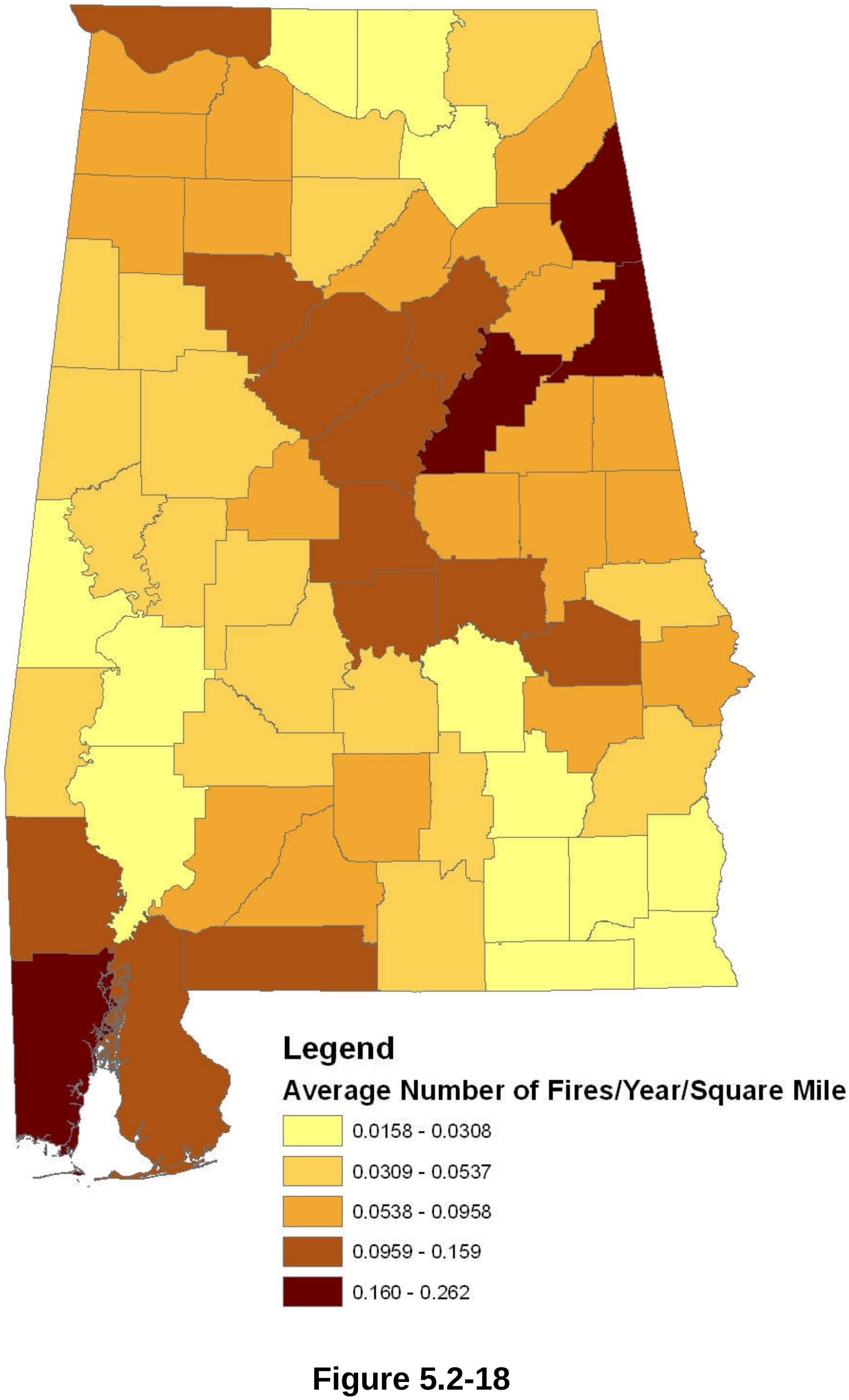


Figure 5.2-18
Number of Fires per Year per Square Mile 1995-2006
Source: Alabama Forestry Commission

5.2.10 Extreme Temperatures

Nature of the Hazard in Alabama

The climate of Alabama is best described as being a humid subtropical climate. This is especially true in the southern part of the State because of its close proximity to the Gulf of Mexico, while the northern parts of the State, especially in the Appalachian Mountains in the northeast, tend to be much closer to a continental climate. Generally, Alabama has very hot summers and mild winters.

Summers in Alabama are among the hottest in the United States, with high temperatures averaging over 90 °F throughout the summer in the entire state making extreme heat fairly common during the summer months. Because extreme heat is so prevalent in the State, residents are accustomed to it and are not significantly impacted; however, extreme heat has been known to induce heat stroke among the elderly; some cases have resulted in death. Additionally, there have been extreme heat events that have had significant impacts on crops and been known to cause deaths among the young and the elderly. **Table 5.2-6** shows the statewide annual high temperatures from 1980-2005.

Winters are generally mild in Alabama, as they are throughout most of the southeastern United States, with average low temperatures around 40 °F in Mobile and around 32° F in Birmingham. The mild winter climate makes extreme cold temperatures fairly uncommon throughout the State. However, because citizens are unaccustomed to the severe cold weather, there have been cases where the cold temperatures have caused death. **Table 5.2-7** shows the statewide annual low temperatures from 1980-2005.

A review of available local hazard mitigation plans revealed that 62 out of 66 counties identified extreme temperature as a hazard to which they are vulnerable.

History of Extreme Temperatures in Alabama

From 1995 through 2006, extreme heat events have caused 18 deaths (three since 2004) and $400 million in crop damages in Alabama. A severe heat wave during the summer of 1995 was responsible for six6 deaths and $400 million dollars worth of crop damage throughout the State.

Table 5.2-6
Annual Observed Maximum Temperatures (1980-2005)
Statewide (Updated)

Year	Maximum Temp	Date	Station
1980	108	17 July	Bessemer 3 WSW
1980	108	17 July	Aliceville
1980	108	17 July	Jasper 4 N
1981	105	25 July	Fayette
1982	104	9 June	Aliceville
1983	106	21 August	Anniston FAA AP
1984	101	21 June	Opelika
1984	101	21 June	Pittsview
1985	105	6 June	Eufaula Wildlife Refuge
1985	105	7 June	Evergreen
1985	105	6 June	Greenville

Table 5.2-6
Annual Observed Maximum Temperatures (1980-2005)
Statewide (Updated)

Year	Maximum Temp	Date	Station
1986	106	31 July	Milstead
1987	107	31 July	Bessemer 3 WSW
1988	103	27 June	Falkville 1 E
1988	103	26 June	Bessemer 3 WSW
1988	103	18 August	Hamilton 3 S
1988	103	30 June	Demopolis Lock and Dam
1988	103	28 June	Brewton 3 ENE
1989	100	25 July	St. Bernard
1989	100	26 August	Greensboro
1989	100	28 August	Atmore State Nursery
1989	100	26 August	Greenville
1989	100	27 August	Jackson
1990	105	19 August	Bessemer 3 WSW
1991	101	5 August	Bessemer 3 WSW
1991	101	7 August	Hamilton 3 S
1991	101	7 August	Rock Mills
1992	101	10 July	Brewton 3 ENE
1992	101	8 July	Jackson
1993	104	27 July	Huntsville WSO AP
1994	98	8 June	Bessemer 3 WSW
1995	105	18 August	Bessemer 3 WSW
1995	105	18 August	Bankhead Lock and Dam
1996	105	4 July	Chatom
1997	101	18 August	Bessemer 3 WSW
1998	105	7 July	Headland
1999	106	20 August	Hamilton 3 S
2000	109	30 August	Vernon 2 N
2001	98	28 July	St. Bernard
2001	98	21 July	Fayette
2001	98	20 July	Tuscaloosa
2001	98	20 July	Greensboro
2001	98	21 July*	Selma
2001	98	24 August	Bessemer 3 WSW
2001	98	3 August	Oneonta
2002	102	5 June	Anniston Metro AP
2002	102	6 September	Centerville 6 SW
2003	98	8 August	Rock Mills
2003	98	30 June	Aliceville
2004	100	4 August	Montgomery
2005	101	21 August	Belle Mina 2 N
2005	101	21 August	Childersburg Water Pit
2005	101	22 August	Brewton 3 SSE

Source: Alabama Office of State Climatologist

From 1995 through 2006, extreme cold events have caused nine9 deaths and $52 million in crop damages in Alabama. The crop damages occurred during a cold snap on March 7, 1996 after a cold front moved through the State and set record low temperatures in nearly all of the northern two thirds of the State.

Table 5.2-7
Annual Observed Minimum Temperatures Statewide

Year	Minimum Temp	Date	Station
1980	2	3 March	Valley Head
1981	2	21 December	Russellville 2
1981	2	12 February*	Valley Head
1982	-8	17 January	Sand Mountain Substation AU
1982	-8	18 January	Valley Head
1983	-10	24 December	Heflin
1984	11	22 January	Bridgeport
1985	-16	21 January	Athens 2
1986	-3	28 January	Valley Head
1987	8	27 January	St. Bernard
1987	8	28 January*	Sand Mountain Substation AU
1987	8	28 January*	Hamilton 3 S
1988	5	11 January	Muscle Shoals FAA Airport
1988	5	6 February	Bessemer 3 WSW
1988	5	12 January	Valley Head
1988	5	8 February	Hamilton 3 S
1988	5	7 February	Vernon 2 N
1989	-7	23 December	Russellville 2
1989	-7	23 December	Haleyville 2 ENE
1990	11	25 December	Valley Head
1991	7	16 February	Winfield 2 SW
1992	8	21 January	Sylacauga 4 NE
1993	2	14 March	Birmingham FAA Airport
1993	2	14 March	Pinson
1994	0	19 January	Athens
1994	0	20 January	Valley Head
1995	6	11 December	Sumiton
1995	6	11 December	Hamilton 3 S
1996	-4	5 February	Bridgeport 5 NW
1997	4	11 January	Athens
1997	4	14 January	Russellville No. 2
1998	11	12 March	St. Bernard
1999	1	6 January	Winfield 2 SW
2000	5	20 December	Haleyville
2000	5	21 December*	Hamilton 3 S
2001	4	4 January*	Hamilton 3 S
2002	9	1 March*	Hamilton 3 S
2003	1	18 January	Bridgeport 5 NW
2003	1	24 January	St. Bernard
2004	11	28 December	Valley Head
2004	11	29 January	St. Bernard
2005	10	24 January	Valley Head

Probability of Extreme Temperatures in Alabama

The annual probability of extreme temperatures occurring is relatively high. However, because the impacts are so localized and relatively moderate when compared to other hazards, the site-specific incidence of extreme temperatures is considered to be low. The qualitative probability rating for extreme temperatures in **Section 5.3** is medium.

5.2.11 Lightning

Nature of the Hazard in Alabama

Lightning typically occurs as a by-product of a thunderstorm. Southern Alabama ranks second in number of annual reported thunderstorms among all areas of the United States behind only Florida. The Gulf Coast averages between 70 and 80 days per year when thunder is reported. This activity decreases somewhat further north in the state, but the northernmost portions of the state report thunder approximately 60 days per year. Occasionally, thunderstorms are severe with frequent lightning and large hail: the central and northern parts of the state are most vulnerable to this type of storm.

A review of available local hazard mitigation plans revealed that 57 out of 66 counties identified lightning as a hazard to which they are vulnerable.

Lightning History in Alabama

According to the latest available information from NOAA, from 1990 to 2006, there were 482 lightning strikes reported in Alabama with 22 fatalities. Lightning caused over $21.6 million in damages. Over 85 percent of these lightning strikes occurred during the six month stretch between March and August with over 60 percent occurring between June and August.

In March 2001, lightning struck a tree near Beatrice Elementary School just before school opened. The lightning ran through the roots of a tree causing the gymnasium to catch on fire. The gym was completely destroyed. The remainder of the school suffered only minor damage from the fire. Damages were estimated to be $500,000.

Lightning was believed to be responsible for a fire in a mobile home in the Shiloh community in June 2002. Three children were killed and two adults and two other children were injured in the fire. The State Fire Marshall said the preliminary investigation indicated the fire started in the general area of the living room around the television. A burn at the base of the utility box outside the home indicated that lightning could have been involved in starting the fire.

In July 2005, an auto body shop in Attalla, Etowah County was struck by lightning. The ensuing fire destroyed the entire business. Another lightning strike hit a clothes dryer in a home in Gadsden. The residents were able to extinguish the fire after it caused minor damages estimated to be $110,000.

In August 2006, lightning struck an elementary school just north of Semmes in Mobile County. The lightning struck the roof starting a fire in the ceiling. It took several hours to put the fire out. Most of the damage was confined to the roof and ceiling area. Damages were estimated to be $800,000.

In August 2006, lightning struck a church in the Mount Vernon area in Mobile County. The strike started a fire and the church was totally destroyed by the blaze. Damages were estimated to be $500,000.

Probability of Lightning in Alabama

The probability of a lightning strike causing damage somewhere in the State of Alabama is quite high. In fact, recent history suggests that a lightning strike will cause damage somewhere in the State of Alabama approximately 28 times per year, or once every 13 days. However, because the impacts are so localized, the site-specific incidence of a lightning strike occurring is considered very low. The qualitative rating for lightning in **Section 5.3** is medium.

5.2.12 Dam Failure

The team is currently coordinating with ADECA to obtain more information on dam failure. At this time, the status of the proposed dam safety legislation (see below) has not changed since adoption of the 2004 plan. Therefore, the statewide risk and vulnerability to dam failure remains unchanged.

Nature of the Hazard in Alabama

Dam safety has been an ongoing hazard mitigation issue in the State of Alabama for the past decade, especially with regard to small dams that are privately owned and poorly maintained. No state law currently exists to regulate any private dams or the construction of new private dams, nor do private dams require federal licenses or inspections. There have been numerous attempts in the State of Alabama to pass legislation that would require inspection of dams on bodies of water over 50 acre-feet or dams higher than 25 feet. Enactment has been hampered by the opposition of agricultural interest groups and insurance companies. Approximately 1,700 privately owned dams would fit into the category proposed by the law.

There are an estimated 2,000 dams of sufficient size that they could pose a threat to property in Alabama. Of these 2,000 dams, approximately 32 hydroelectric, navigation, and flood control project dams are federally regulated and fall under the jurisdiction of the Tennessee Valley Authority, U. S. Army Corps of Engineers, Alabama Power Company, and Alabama Electric Cooperative, Inc. A number of existing dams have inadequate spillways and embankments and many are poorly maintained. Seventeen years ago, approximately 186 dams were classified by the Corps of Engineers as high-hazard dams, posing a significant safety hazard. **Figure 5.2-19** shows the number of high-hazard dams by county.

A review of available local hazard mitigation plans revealed that 53 out of 66 counties identified dam failure as a hazard to which they are vulnerable.

Dam Failure History in Alabama

During the 1990 flood of February 3 to 17, three earthen dams in Alabama sustained damages. The Holly Brooke Lake Dam in Shelby County was saturated to the point that the face of the dam slumped. If the water pressure had not been reduced, total failure of the dam might have occurred. As a result of the dam's condition, six families were evacuated while the water level on the 55 acre pond impounded by the dam was lowered.

During the March 23, 1990 flooding disaster, a dam was overtopped at Magnolia Shores Lake in Crenshaw County, causing damage to the downstream slope. To prevent a break in the dam, a channel was dug around the dam to lower the water and the lake was then drained by a controlled breach of the dam.

The C. D. Clark Dam in Dozier, Crenshaw County, failed and washed out 50 yards of northbound U.S. Highway 29. Lake Tholocco, a 600-acre lake on the Fort Rucker reservation near Ozark, was also drained because of excessive flow through its emergency spillway.

There were reports of 160 dam breakages during the July 1994 floods; however, because there is no state law or regulation concerning dam safety that requires reporting of breaks or other problems, not all breaks are reported. Information on dam breakages is submitted by local officials.

Probability of Dam Failure in Alabama

The generally accepted safety standard for the design of dams is the Inflow Design Flood (IDF) which is "… the flood flow above which the incremental increase in water surface elevation downstream due to failure of a dam or other water retaining structure is no longer considered to present an unacceptable additional downstream threat" (Interagency Committee on Dam Safety, October 1998). The inflow design flood is the upper limit of the Probable Maximum Flood (PMF), which is the estimated flood flow from the Probable Maximum Precipitation (PMP). The PMP is "… the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of the year" (US Department of Commerce and US Army Corps of Engineers, June 1988). However, it must be noted that there are numerous dams in existence whose discharge capabilities were designed and built using methods that are now considered potentially unsafe.

The areas impacted by a dam failure are analyzed on the basis of "sunny day" failures and failures under flood condition. Typically, the dam-break floodplain is more extensive than the floodplain used for land use development purposes, and few communities consider upstream dams when permitting development. The potential severity of a full or partial dam failure is influenced by two factors: the amount of water impounded, and the density, type, and value of development and infrastructure downstream.

Alabama has no dam safety program and legislation. Individuals from Natural Resources, the Catfish Farmers Federation, Alabama Power Company and several other agencies have formed a committee to promote state dam safety legislation. A draft legislative instrument was written, and the Dam Safety initiative has been transferred to the Alabama Department of Economic Affairs. The Alabama Office of Water Resources is supporting the establishment of an Alabama Dam Security and Safety Program. The legislation to establish this program has been under development for several years, but was reemphasized in 2002 when OWR assumed overall management of dam safety and National Flood Insurance Program initiatives from the AEMA. This legislation and ADECA's efforts are further discussed in **Section 4.3**.

Once established, the program will provide an up-to-date inventory of dams in Alabama. A full inventory of dams will help to benefit public safety and emergency response operations in the event of a natural or other disaster. It will also provide for the inspection and permitting (certification) of certain dams in order to protect the citizens of Alabama by reducing the risk of failure of such dams.

The probability of future occurrences cannot be characterized on a statewide basis because of the lack of information available. The qualitative probability is rated low in **Section 5.3** because the overall area affected I slow and impacts are localized. This rating is intended only for general comparison to other hazards that are being considered.

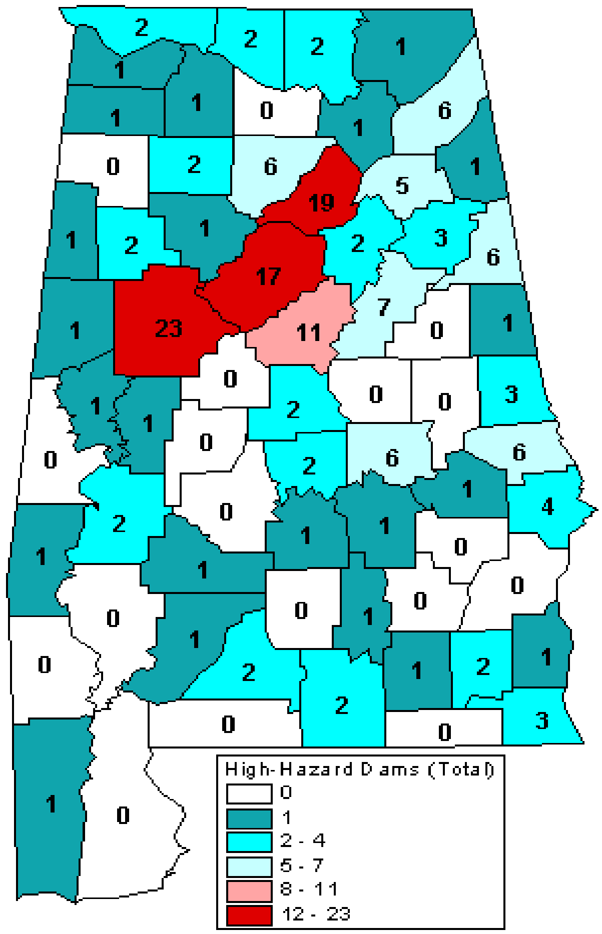


Figure 5.2-19
Alabama High Hazard Dams by County
Source: National Oceanographic and Atmospheric Administration, 1997

5.2.13 Tsunamis

Nature of the Hazard in Alabama

There are no records of tsunamis occurring in Alabama, and very little research has been conducted concerning tsunamis in the Gulf of Mexico in general. However, the nature of the hazard in Alabama is expected to be comparable to storm surge. A strong Category 2 or 3 hurricane could push up to 15 feet of water onto shore, while a Category 5 hurricane could generate a 30 foot storm surge. A tsunami in the Gulf of Mexico could be expected to generate similar impacts. **Figures 5.2-1** and **5.2-2** show areas susceptible to storm surges of hurricanes. It can be expected that these areas, specifically the coastal areas of Baldwin and Mobile Counties, would also be impacted by a tsunami.

There are several scenarios that could generate a tsunami impacting coastal Alabama. Earthquakes have been known to occur in both the Gulf of Mexico and the Caribbean Sea. If an earthquake of high enough magnitude occurred in one of these areas, it could generate a tsunami that could impact the Gulf Coast. The area is also at risk from a tsunami that could be generated elsewhere in the Atlantic Basin. The potentially catastrophic collapse of the Canary Island volcanoes could generate a tsunami with impacts across the Atlantic and Gulf Coasts. It must be stressed, however, that the probability of any of these events occurring is remote.

A review of available local hazard mitigation plans revealed that only 1 out of 66 counties identified tsunamis as a hazard to which they are vulnerable.

Tsunami History in Alabama

There are no records of tsunamis impacting Alabama. Impacts from storm surge events described in **Section 5.2.1** can be used as a general model for the possible effects of a tsunami in Alabama.

The closest Alabama has come to experiencing a tsunami in recent history occurred on September 10, 2006. An earthquake of magnitude 5.8 struck. The earthquake was centered in the Gulf of Mexico approximately 500 miles south of Mobile. Mild shaking was felt in Florida, Alabama, and Georgia, but no damage was recorded. According to the USGS, the quake was not strong enough to produce a tsunami.

Since there is no evidence of tsunamis impacting Alabama, a summary of tsunami events that have occurred elsewhere in the Atlantic Basin is included below.

On November 1, 1755, an earthquake struck Lisbon, Portugal and caused a tsunami that engulfed the harbor and rushed up the Tagus River. Between the earthquake and the tsunami, an estimated 90,000 people died. Tsunamis up to 66 feet in height swept the coast of North Africa, and struck Martinique and Barbados across the Atlantic. A ten foot tsunami hit the southern English coast. Galway, on the west coast of Ireland, was also hit, resulting in the partial destruction of the Spanish Arch.

On November 18, 1929, an earthquake of magnitude 7.2 occurred beneath the Laurentian Slope on the Grand Banks. The quake was felt throughout the Atlantic Provinces of Canada and as far west as Ottawa and as far south as Claymont, Delaware. The resulting tsunami measured over 21 feet in height and took about 2.5 hours to reach the Burin Peninsula on the south coast of Newfoundland, where 29 people lost their lives in various communities. It also snapped telegraph lines laid under the Atlantic.

In 1991, a 7.6 magnitude earthquake in Costa Rica produced a six foot high tsunami that flooded nearly 1,000 feet inland in the Cahuita-Puerto Viejo area on the Caribbean side of the country. Tsunamis were also reported on Bastimentos, Carenero and Colon Islands and at Portobello, Panama. The maximum amplitude of the tsunami in Panama was about two feet.

Tsunami Probability in Alabama

As there are no records of tsunamis occurring in Alabama, and therefore little information available regarding tsunamis in Alabama, it is difficult to determine a quantitative probability for tsunamis in Alabama. However, the lack of historical evidence indicates, at least qualitatively, that this probability is quite low.

5.3 Methodology for Identifying Natural Hazards for Additional Analysis

Although the Interim Final Rule (see **Appendix B**) requires that all natural hazards affecting the State must be included in a detailed overview, it is not practical or desirable to perform detailed statewide risk assessments on all these hazards. This is because many of the hazards have little probability of affecting the State and/or it is difficult to mitigate their effects. Because of this, the SHMT and FEMA determined that it would be desirable to reduce the initial list of hazards to those that have the most potential for damaging the State or its citizens in the future.

To reduce the overall number of hazards that will be given detailed risk assessments, AEMA developed a rating system that uses the following five criteria to rate each hazard in two categories: relative probability of occurrence, and capacity for mitigation. The term “relative” probability of occurrence is used here because the determination is less rigorous than the one used in the full risk assessment. The purpose of this ranking methodology is to rate Alabama risks relative to each other, in order to identify the most significant ones, and concentrate the risk assessment on these. The hazards are given low, medium or high ratings in the two categories. This method was initially suggested by FEMA Region IV, at the February 26, 2004 SHMT meeting. The ratings were presented to the SHMT in draft at its meeting on April 8, 2004. The SHMT reviewed and approved the rankings at that meeting.

The criteria used were:

1. History - High rating indicates that the hazard has affected the State often in the past, and that the hazard has occurred often and/or with widespread or severe consequences.

2. Presence of susceptible areas - High rating indicates that the State has numerous facilities, operations or populations that may be subjected to damage from the hazard.

3. Data availability - High rating indicates that sufficient quality data is available to permit an accurate and comprehensive risk assessment.

4. Federal disaster declarations - High rating indicates that the State has received numerous disaster declarations for the particular hazard.

5. Potential for mitigation - High rating indicates that there are ways to address the hazard, and that the methods are technically feasible and have the potential to be cost-effective (i.e. mitigation measures are available at a reasonable cost, and damages to property, lives and/or community functions would be reduced or eliminated).

The SHMT determined that hazards with “high” ratings in both the probability and ease of mitigation categories are provided detailed and comprehensive risk assessments in later subsections. Those that received medium or low ratings in either category are not provided detailed risk assessments, but are in some cases included as risks to State-owned facilities, and are also included in mitigation goals, objectives, strategies and actions. The hazards that received high ratings in each category were floods, high wind (which includes hurricanes and tornados), and earthquakes. In future updates to the plan it may be desirable to undertake detailed risk assessments of some of the other hazards (those that did not receive High/High ratings in this analysis).

This classification process was presented to the State Hazard Mitigation Team during its general meeting on April 8, 2004, and was approved by the SHMT for use in the hazard mitigation plan. For the 2007 plan update, the rating system and results were presented to the SHMT in its April 25, 2007 meeting. The group reconsidered and re-approved the methodology and results. **Table 5.3-1** shows all of the hazards considered in this methodology, and the rankings assigned by the SHMT.

Note that in the 2007 update, hurricane hazards were divided into wind and flooding hazards and merged into those categories in the risk assessment. At the request of the SHMT and AEMA, tsunamis were added to the list of hazards that were considered in this ranking, and later profiled.

Table 5.3-1
Qualitative Rankings of 16 Initial Hazards,
based on Probability of Occurrence and Mitigation Potential

Hazard	Data Sources	Probability Rating	Mitigation Potential Rating	Disposition in Plan
Flooding (includes storm surge, riverine, and flash flooding)	• National Oceanic and Atmospheric Administration (NOAA) Storm Events Database • National Oceanic and Atmospheric Administration (NOAA) Alabama Coastal Hazards Assessment • National Weather Service • Flood Insurance Rate Map (FIRM)	**H**	**H**	Profile and risk assessment
High Winds (Includes hurricanes, tornados and windstorms)	• NOAA Storm Events and Alabama Coastal Hazards Assessment • National Weather Service • Alabama Disaster Center	**H**	**H**	Profile and risk assessment
Winter storms	• NOAA Storm Events and Alabama Coastal Hazards Assessment • Alabama Disaster Center	**H**	**M**	Profiled, but not part of detailed risk assessment
Landslides	• Geological Survey of Alabama • United States Geological Survey (USGS)	**L**	**L**	Profiled, but not part of detailed risk assessment
Sinkholes and Land Subsidence	• Geological Survey of Alabama • United States Geological Survey (USGS)	**L**	**L**	Profiled, but not part of detailed risk assessment
Earthquakes	• NOAA Alabama Coastal Hazards Assessment • National Seismic Hazard Mapping Project map, USGS • Geological Survey of Alabama	**H**	**H**	Profile and risk assessment (2007 Update)

Table 5.3-1
Qualitative Rankings of 16 Initial Hazards,
based on Probability of Occurrence and Mitigation Potential

Hazard	Data Sources	Probability Rating	Mitigation Potential Rating	Disposition in Plan
Drought	• NOAA	**M**	**L**	Profiled, but not part of detailed risk assessment
Hail	• NOAA	**M**	**L**	Profiled, but not part of detailed risk assessment
Wildfire	• Alabama Forestry Commission	**M**	**L**	Profiled, but not part of detailed risk assessment
Extreme Temperatures	• NOAA	**M**	**L**	Profiled, but not part of detailed risk assessment
Lightning	• NOAA • National Weather Service	**M**	**L**	Profiled, but not part of detailed risk assessment
Dam Failures	• Alabama Department of Economic and Community Affairs (ADECA) • NOAA	**L**	**L**	Profiled, but not part of detailed risk assessment
Tsunamis	• NOAA • USGS	**L**	**L**	Profiled, but not part of detailed risk assessment
Hazardous Materials Incidents	• Environmental Protection Agency (EPA)	**H**	**L**	Not profiled or part of detailed risk assessment because outside of the scope of natural hazard mitigation plan
Manmade Hazards	• U.S. Center for Disease Control, Alabama Department of Public Health	**M**	**L**	Not profiled or part of detailed risk assessment because outside of the scope of natural hazard mitigation plan

As expected, the classification process provided a clear stratification of the hazards based on these criteria. Floods and high winds present the highest risk to the State based on this limited assessment, as in the 2004 Plan. In addition, new data and a better understanding of earthquakes have caused it to achieve a high rating in both categories. Therefore, floods, high winds, and earthquakes are afforded more detailed risk assessments in **Section 5.5.**

5.4 General Discussion of Vulnerability and Risk

Prior to reading the following sections about statewide risk, it is important to understand the meanings of several terms that appear in both the Federal hazard mitigation planning rules and this plan. The terms *risk* and *vulnerability* appear many times in both places, and the terms are defined below and given some context in terms of this plan.

5.4.1 Definition of Risk

In the context of hazard mitigation planning, *risk* is defined as the expected future losses to a community, business or State from the effects of natural events. The concept has several other concepts embedded in it. These are described below.

Probability is the likelihood that events of particular severities will occur. The ability of scientists and engineers to calculate probability varies considerably depending on the hazard in question. In many areas of the country, flood studies of various kinds can provide reasonably accurate estimates of how often water will reach particular places and elevations. On the other hand, tornados and earthquakes are nearly impossible to predict, except in the most general sense. Probability is a key element of risk because it determines how often the events are likely to happen.

It is important to note that risk is cumulative. This means that although natural hazards may not affect a place in any particular year, the probability of one or more events (in some places multiple events) occurring “adds up” over time. Risk calculations incorporate all expected future events – usually with some limit on the time horizon that is considered – in order to account for both repetitive events and for the probabilities that accumulate over time. For example, although earthquakes are infrequent in most places, there is some possibility of an earthquake occurring in any year. Therefore, the possibility of an earthquake occurrence increases over time.

Severity is the measure of “how bad” a hazard event is. Severity is measured in various ways, depending on the hazard. For example, floods can be measured in terms of depth, velocity, duration, contamination potential, debris flow, and so forth. Tornados are measured primarily in terms of wind speed, although their duration on the ground can also be an important factor in their destructiveness.

Vulnerability is the extent to which something is damaged by a hazard. Vulnerability is very often measured using “damage functions.” These are based on studies of how buildings perform when they are exposed to hazards. Similar functions are available for infrastructure and other physical assets. Injury and mortality functions (how many people are injured or die during events) are also sometimes used as indicators of vulnerability, but these are generally not as reliable as functions for physical assets because there are many more variables.

Value is how much it would cost to replace an asset that may be damaged or lost due to the impact of a natural hazard. There are many sources of this information, including standard cost-estimating guides, experience of local officials, and statistical studies.

Risk is expressed in dollars of future expected losses. It is calculated in this way so that different kinds of losses can be adequately compared. For example, without a common basis for comparison, it would be virtually impossible to determine if the risk of injury from future earthquakes is greater than damage to vehicles in future floods. When the expected losses are converted to and expressed in dollars, the damages can be compared and prioritized. In combination with the concepts discussed above, almost any kind of hazard can be quantified and its risk expressed. The exceptions to this idea are *infrequent* or *highly unpredictable* events such as meteors impacting the earth, or manmade hazards such as terrorism. In the cases, the element of probability is virtually impossible to characterize, and the risk calculus cannot be accurate without it.

Risk calculations often start with an annualized (yearly) loss figure, which is then projected into the future for some pre-determined period of time, then *discounted* to today's value using a discount rate. This is a standard economic methodology that is required by the Federal government for analyses of many of its programs, including FEMA's mitigation initiatives. Those who are interested can read more about the required methodology, which is described in Office of Management and Budget (OMB) Circular No. A-94.

The risk calculation techniques that were used as the basis for this plan are carefully described in the sections that follow, and conform to standard methodologies that FEMA and other Federal agencies have been using for many years. A discount rate of 7 percent and a 30 year time horizon is used in all calculations unless otherwise specified. The 7 percent discount rate was the OMB-mandated rate at the time this plan was developed, and the 30 year horizon is a medium-term figure that blends the expected life of a variety of potential mitigation actions. The sections in the plan dealing with specific mitigation activities use other time horizons as indicated, but the discount rate always remains at 7 percent.

5.5 Vulnerability Assessment and Loss Estimation

Background

Because it forms the basis of the State hazard mitigation plan, the State-level risk assessment should be as comprehensive as possible. As discussed in **Section 5.3**, the SHMT developed an initial list of hazards that were identified and profiled in **Section 5.2**. The SHMT then used a ranking methodology to determine which of these would be further analyzed to determine statewide potential losses. The ranking methodology used five criteria to determine if each hazard should be included in the plan. These criteria are briefly reviewed below. Hazards with the highest rankings are included in the risk assessments in the present section.

- History - High rating indicates that the hazard has affected the State often in the past, and that the hazard has occurred often and/or with widespread or severe consequences.

- Presence of susceptible areas - High rating indicates that the State has numerous facilities, operations or populations that may be subjected to damage from the hazard.

- Data availability - High rating indicates that sufficient quality data is available to permit an accurate and comprehensive risk assessment.

- Federal disaster declarations - High rating indicates that the State has received a relatively high number of disaster declarations for the particular hazard.

- Potential for mitigation - High rating indicates that there are ways to address the hazard, and that the methods are technically feasible and have the potential to be cost-effective (i.e. mitigation measures are available at a reasonable cost, and damages to property, lives and/or community functions would be reduced or eliminated).

The SHMT used this system to identify floods, tornados and hurricanes as the most significant hazards in Alabama in 2004. However, this plan update separates the hurricane hazard into separate wind and flood (including surge) effects, so hurricanes are not listed as a separate hazard. In addition, tornados were included in the discussion of the wind hazard. Therefore, this section includes detailed risk assessments for flood and high wind hazards.

As explained in **Section 5.4**, the risk assessment is a determination of expected future losses, and is analogous to the term “loss estimation” in this document. Risk assessment/loss estimation is based on several closely related factors, including the probability and severity of hazards, and the vulnerability of assets Statewide, including property, people and functions such as businesses and government operations. Although it is possible to determine hazard probability and severity with some accuracy, vulnerability assessments are best conducted on an asset-specific basis, something that is not possible given the scope of this Plan. Because of this, the results of the vulnerability assessments and loss estimates in this section should be considered general in nature, and most accurate relative to each other.

The methods used for risk calculations vary by hazard. The methodologies are discussed in detail in the subsections below.

5.5.1 General Risk

Methodology 1 - Risk Estimates from Local Mitigation Plans

Requirement §201.4(c) (2) (ii) of the IFR states that “the State risk assessment shall include an overview and analysis of the State’s vulnerability to the hazards…based on estimates provided in local risk assessments.” In reviewing this requirement, AEMA and the SHMT determined that the primary source for local vulnerability and risk assessments were should be the county hazard mitigation plans.

During the development of the initial plan in 2004, the SHMT found that the local plans and risk assessments seldom provided enough detail to be directly incorporated into this document. Instead, local jurisdictions were surveyed about their risks and a small sampling of more developed risk assessments were used to develop an overall picture of the risk and vulnerability of each county statewide. At the start of this plan update process, 64 out of 67 counties had approved mitigation plans, two counties had plans that were far along in the plan development process, and only one county did not have a plan ready for review.

As part of the State plan update process, the SHMT reviewed all of the local plans in detail. **Table 5.5-1** below summarizes the risk determinations from local plans. AEMA reviewed the 66 available local mitigation plans for incorporation into the risk assessment of this plan update (Bullock County has not yet submitted a plan to AEMA, but is expected to by the end of June 2007; at that time, pertinent information, if available, will be incorporated into this risk assessment). As expected, there is substantial variation in the quality and level of detail in the plans, specifically the risk assessment sections. Nevertheless, the local plans offered enough additional information that they could be assessed in detail for this update. The following is a discussion of the local plans with regard to risk assessment, and a summary table (**Table 5.5-1**) of risk projections by county. This review process is explained in greater detail in **Section 7.3.**

Table 5.5-1
Summary of Annual Potential Loss Estimates Extracted from Local Hazard Mitigation Plans for Specific Hazards

County	Flood	Hurricane	Tornado	Wind
Autauga	$60,452	$380,000	$281,577	$281,577
Baldwin	$180,000	$26,200,000	$162,188	$40,770
Barbour	n/a	n/a	n/a	n/a
Bibb	$100,000	$50,000	$50,000	$750,000
Blount	$29,600	n/a	$105,000	$46,000
Butler	$15,557	n/a	$19,113	$5,245
Calhoun	$4,565	$4,480	$64,634	$64,634
Chambers	n/a	n/a	$110,300	$73,272
Cherokee	$26,625	n/a	$72,250	$37,000
Chilton	$19,320	n/a	$462,715	n/a
Choctaw	$96,000	n/a	$9,000	$101,250
Clarke	$65,833	n/a	$112,052	$11,382
Clay	$16,423	$31,194	$487,166	n/a
Cleburne	$11,320	$65,672	$33,333	$5,509
Coffee	n/a	n/a	n/a	n/a
Colbert	$64,600	n/a	$68,485	$23,850
Conecuh	$79,250	n/a	$25,300	$39,550
Coosa	$1,200	$65,672	$37,320	$55,980
Covington	n/a	n/a	n/a	n/a
Crenshaw	$81,000	n/a	$73,000	$60,785
Cullman	$81,250	n/a	$2,048	$3,296
Dale	n/a	n/a	$836,458	$10,226
Dallas	$14,400	n/a	$322,000	$1,037,000
DeKalb	n/a	n/a	$1,051,055	$285,042
Elmore	n/a	n/a	n/a	n/a
Escambia	$220,428	n/a	$21,511	$54,430
Etowah	$7,660	$105,263	$125,640	$349,000
Fayette	$200,000	n/a	$500,000	$90,000
Franklin	$27,500	n/a	$27,571	$24,524
Geneva	n/a	n/a	n/a	n/a
Greene	$2,000	$1,000	$1,000,000	$25,000
Hale	$45,000	$150,000	$50,000	$120,000
Henry	n/a	n/a	n/a	n/a
Houston	$1,062,500	$8,275,862	$366,852	$366,852
Jackson	n/a	n/a	$676,404	$177,644
Jefferson	$1,037,000	n/a	$5,300,000	$73,650
Lamar	$28,000	$50,000	$400,000	$25,000
Lauderdale	$4,703,750	n/a	$168,071	$42,623
Lawrence	$14,040	n/a	$79,840	$47,000
Lee	n/a	n/a	n/a	n/a
Limestone	$113,734	n/a	$1,106,529	$202,204
Lowndes	$2,855	n/a	$11,231	$4,782
Macon	$1,333	n/a	$14,685	$7,019
Madison	$265,833	n/a	$10,000,000	$98,260
Marengo	$19,000	n/a	$51,583	$2,912
Marion	$19,250	n/a	$898,920	$216,576
Marshall	$26,625	n/a	$72,250	$37,000
Mobile*	$180,333	$26,200,000	$88,615	$42,667

Table 5.5-1
Summary of Annual Potential Loss Estimates Extracted from Local Hazard Mitigation Plans for Specific Hazards

County	Flood	Hurricane	Tornado	Wind
Monroe	$4,300	n/a	$74,000	$108,000
Montgomery	$45,000	n/a	$260,000	$96,500
Morgan	$3,420	n/a	$313,212	$27,898
Perry	$4,250	n/a	$276,316	$2,143
Pickens	$100,000	$2,000	$500,000	$52,000
Pike	n/a	n/a	n/a	n/a
Randolph	$67,375	$110,526	$231,250	$231,250
Russell	n/a	n/a	n/a	n/a
St. Clair	$41,889	n/a	$917,605	$18,692
Shelby	$41,889	n/a	$612,846	$32,695
Sumter	$172,500	n/a	$238,333	$4,050
Talladega	$225,926	$105,263	$155,760	$155,760
Tallapoosa	$1,880	$88,000	$244,083	$24,555
Tuscaloosa	$25,000	$2,235	$1,320,000	$17,880
Walker	$64,000	n/a	$68,485	$23,850
Washington	$30,000	n/a	$12,242	$606,000
Wilcox	$5,400	n/a	$2,931	$3,116

*Includes results from both the Incorporated and Unincorporated Mobile Plans

Although there is some expected variation in the methods used in these local risk assessments, most of them were based on a standard methodology of using past damages to project future losses. The SHMT did not perform a detailed assessment of each county's methodology to validate them; however, it can be assumed that they all have at least a basic level of technical validity. After initial review of loss estimates for all hazards in all local plans, it was determined that ample usable information was only available for floods, hurricanes, tornados, and wind. Although the local plans did include information on loss estimates for other hazards, it was widely inconsistent to the point of being unusable. **Table 5.2-2** shows the cumulative risk of these hazards by county.

Table 5.5-2
Total Potential Loss Estimates from Local Hazard Mitigation Plans

County	Total Estimated Risk
Baldwin	$26,582,958
Mobile*	$26,511,615
Madison	$10,364,093
Houston	$10,072,065
Jefferson	$6,410,650
Lauderdale	$4,914,444
Limestone	$1,422,467
Dallas	$1,373,400
Tuscaloosa	$1,365,115
DeKalb	$1,336,097
Marion	$1,134,746
Greene	$1,028,000
Autauga	$1,003,607
St. Clair	$978,186

Table 5.5-2
Total Potential Loss Estimates from Local Hazard Mitigation Plans

County	Total Estimated Risk
Bibb	$950,000
Jackson	$854,048
Dale	$846,684
Fayette	$790,000
Shelby	$687,430
Pickens	$654,000
Washington	$648,242
Talladega	$642,709
Randolph	$640,401
Etowah	$587,563
Clay	$534,782
Lamar	$503,000
Chilton	$482,035
Sumter	$414,883
Montgomery	$401,500
Winston	$395,799
Hale	$365,000
Tallapoosa	$358,518
Morgan	$344,531
Escambia	$296,369
Perry	$282,710
Crenshaw	$214,785
Choctaw	$206,250
Clarke	$189,267
Monroe	$186,300
Chambers	$183,572
Blount	$180,600
Coosa	$160,172
Colbert	$156,935
Walker	$156,335
Conecuh	$144,100
Lawrence	$140,880
Calhoun	$138,313
Cherokee	$135,875
Marshall	$135,875
Cleburne	$115,833
Cullman	$86,594
Franklin	$79,595
Marengo	$73,495
Butler	$39,915
Macon	$23,037
Lowndes	$18,868
Wilcox	$11,447
Barbour	Not in local plan
Coffee	Not in local plan
Covington	Not in local plan
Elmore	Not in local plan
Geneva	Not in local plan

Table 5.5-2
Total Potential Loss Estimates from Local Hazard Mitigation Plans

County	Total Estimated Risk
Henry	Not in County plan
Lee	Not in County plan
Pike	Not in County plan

*Includes results from both the Incorporated and Unincorporated Mobile Plans

The reliability of these risk projections cannot be determined without additional study, but the pattern in the data is consistent with results in other parts of this section, with the counties closest to the coast and those with the highest populations projecting the most risk. **Figure 5.5-1 thru 5.5-5**, below show the county by county potential loss estimates for flooding, hurricanes, tornados, winds, and cumulative risks for the 66 counties with available Hazard Mitigation Plans as of 2007 State Plan Update.

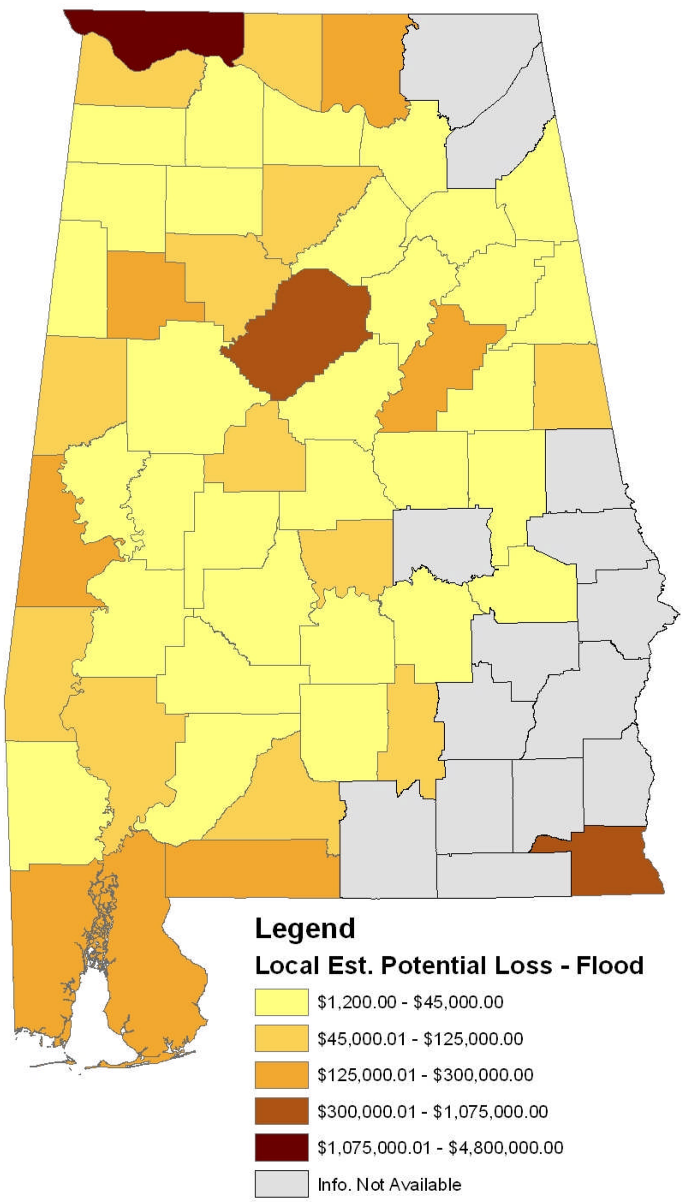
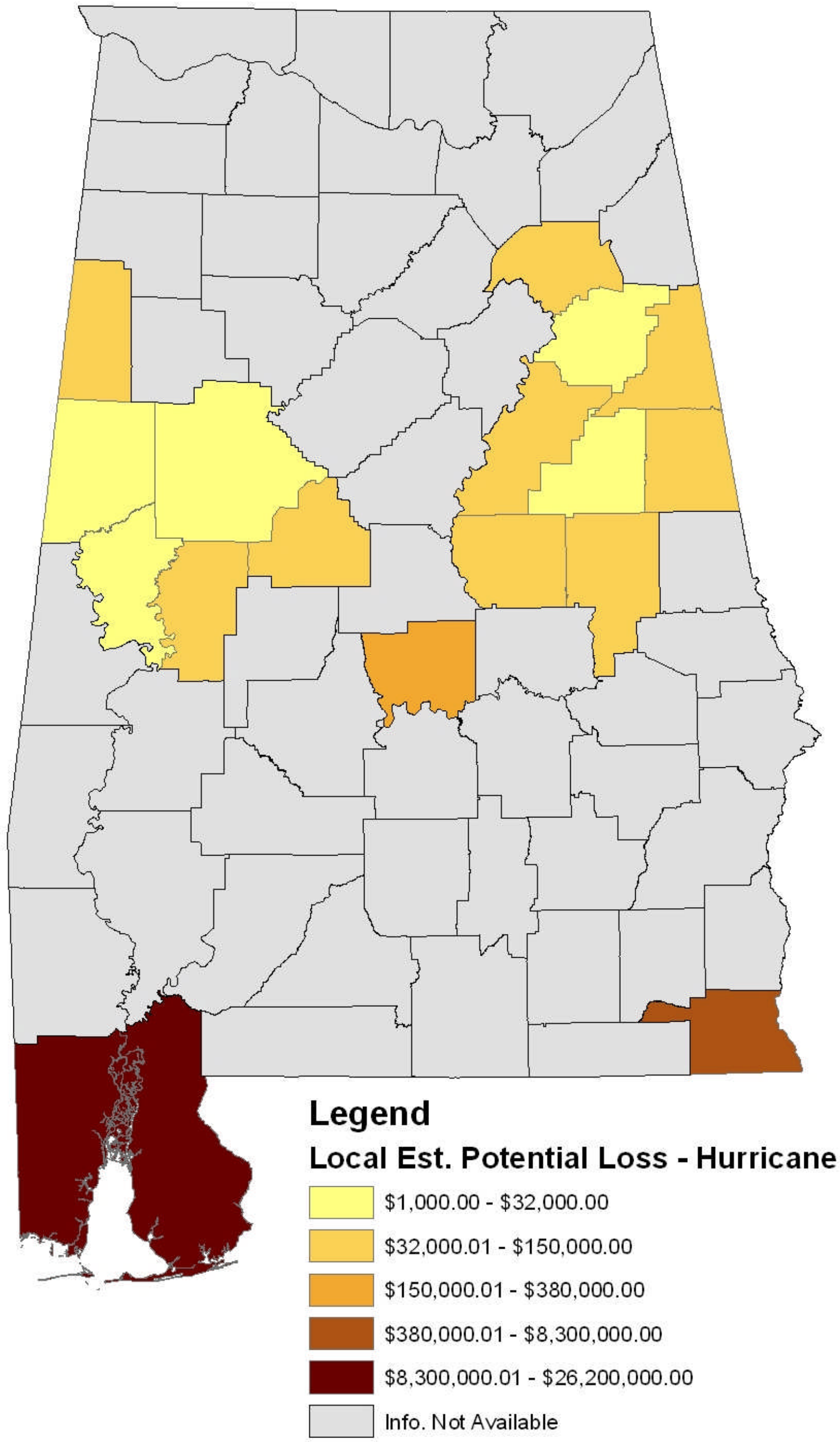


Figure 5.5-1
Annual Loss Estimates from Flooding Extracted from Local Hazard Mitigation Plans
Source: Alabama Local Hazard Mitigation Plans

Figure 5.5-2 Annual Loss Estimates from Hurricanes Extracted from Local Hazard Mitigation Plans

Source: Alabama Local Hazard Mitigation Plans



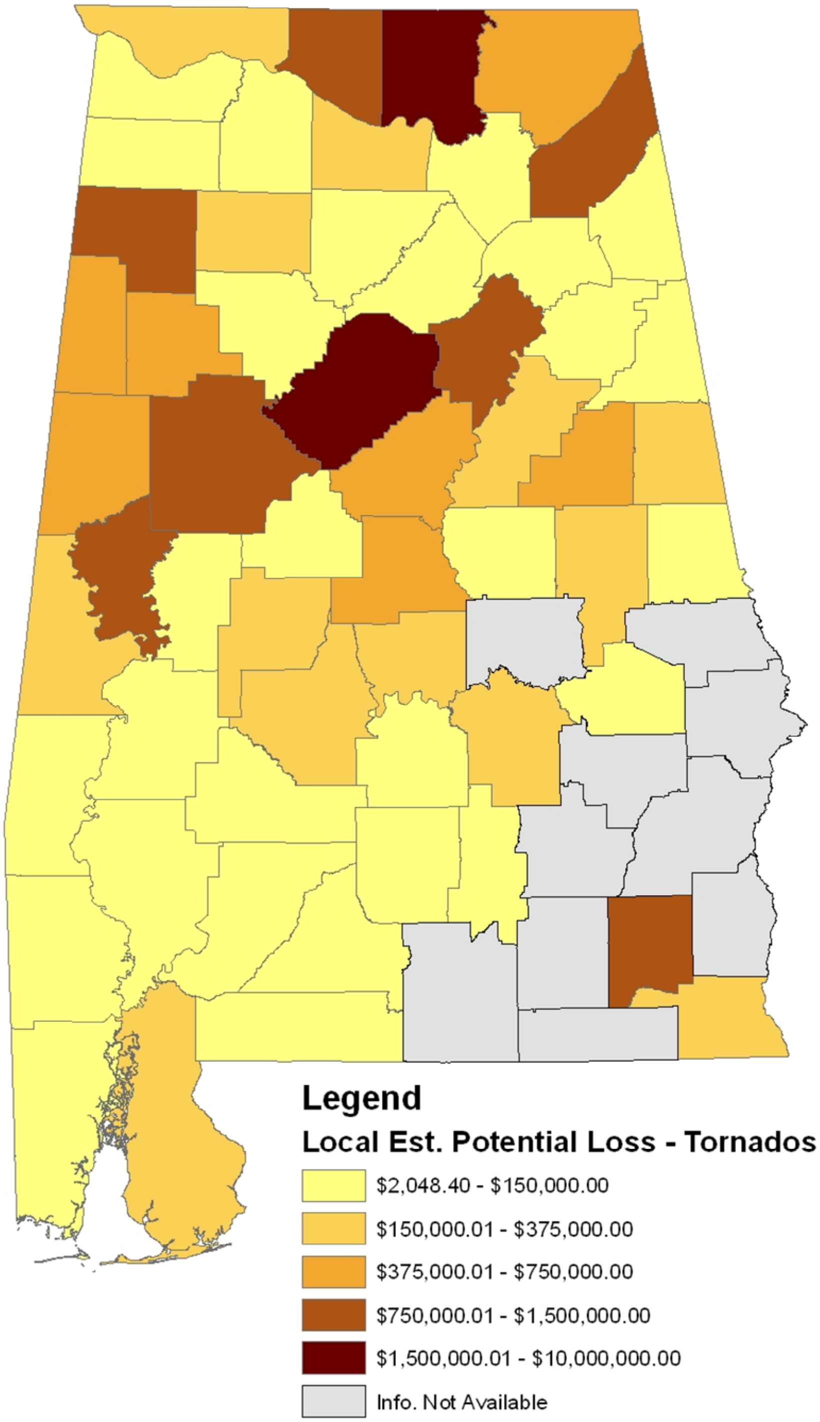
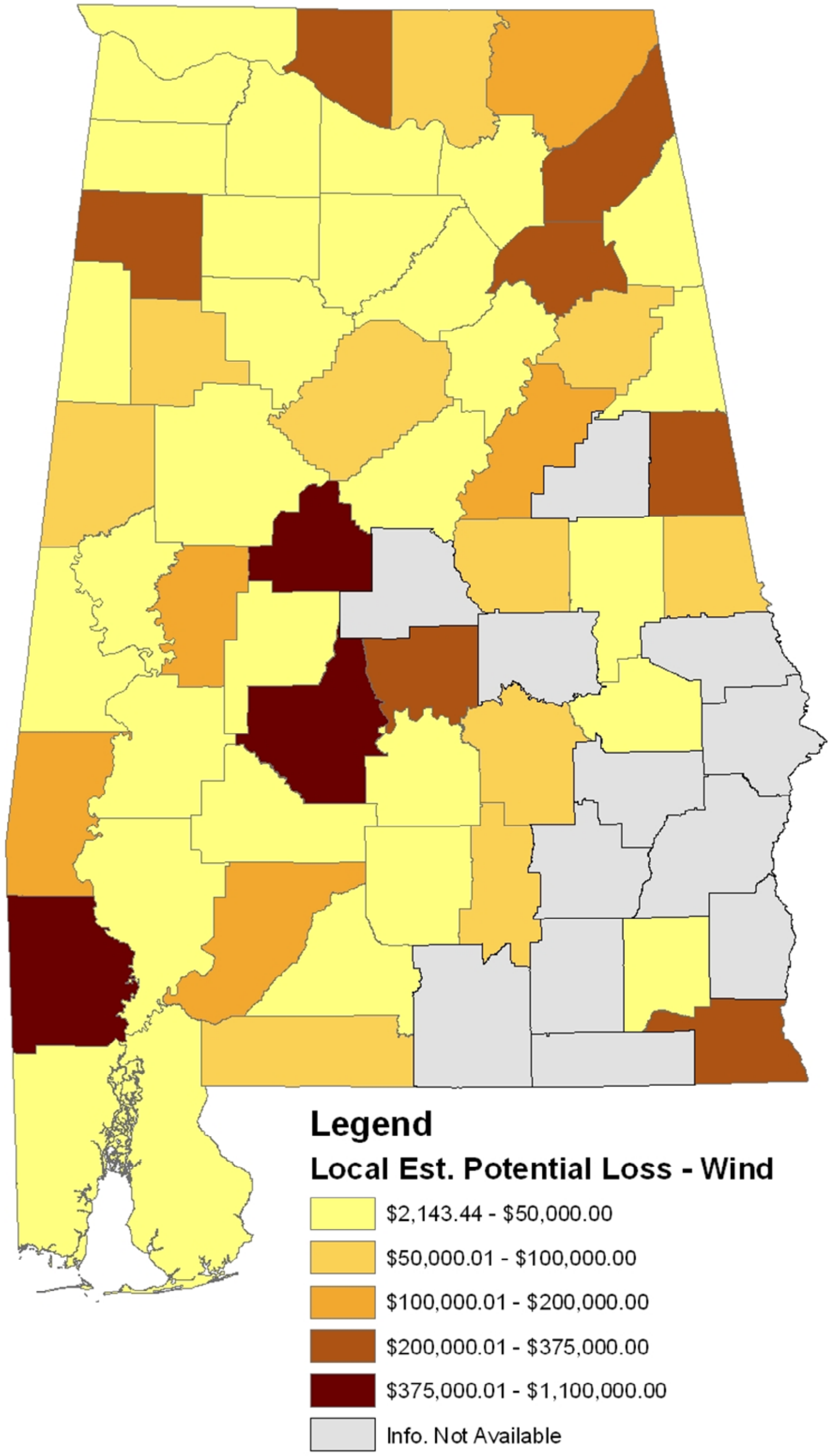


Figure 5.5-3 Annual Loss Estimates from Tornados Extracted from Local Hazard Mitigation Plans

Source: Alabama Local Hazard Mitigation Plans

Figure 5.5-4
Annual Loss Estimates from Windstorms Extracted from Local Hazard Mitigation Plans
Source: Alabama Local Hazard Mitigation Plans



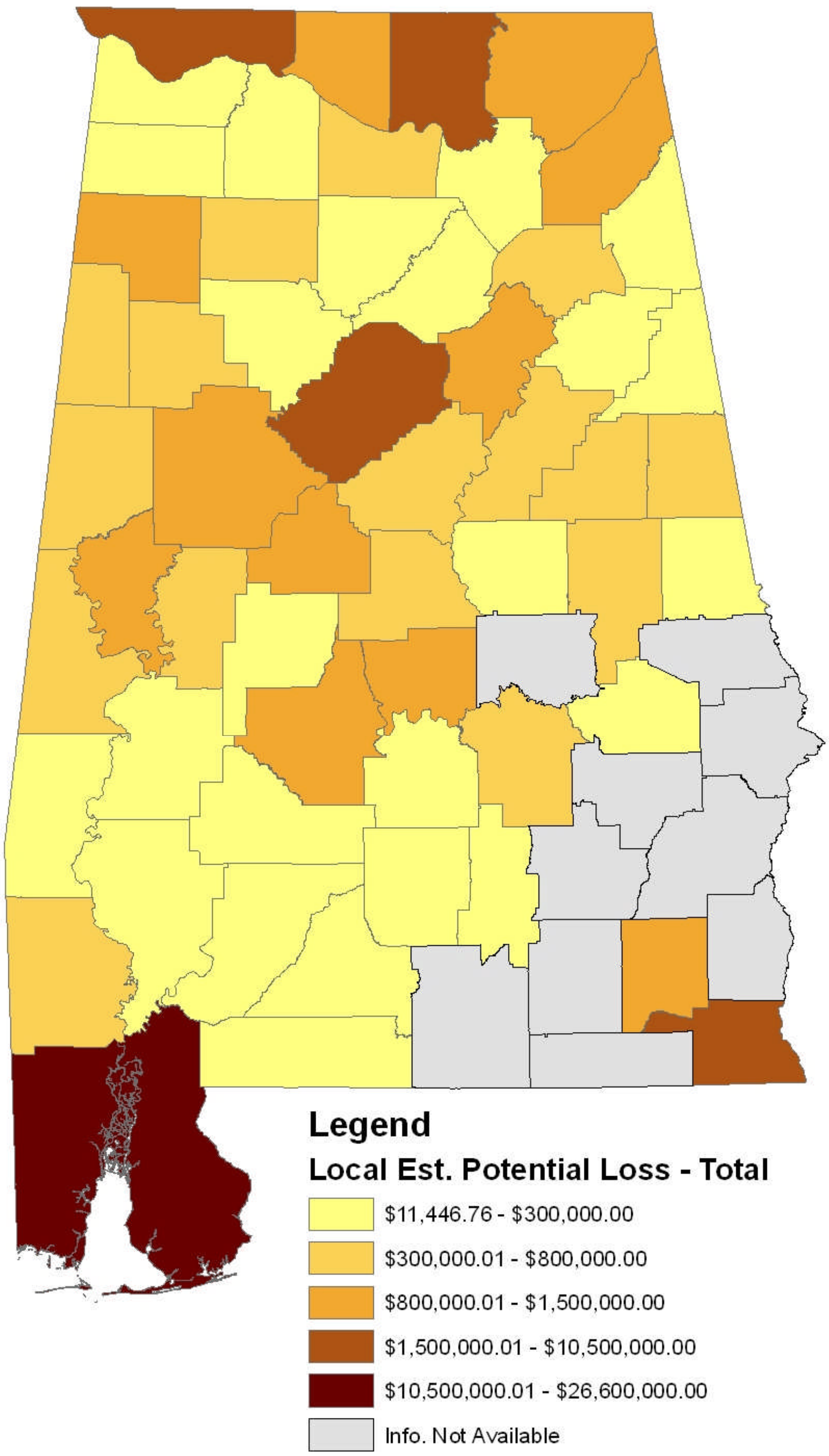


Figure 5.5-5
Total Annual Loss Estimates from Selected Hazards Extracted from Local Hazard Mitigation Plans

Source: Alabama Local Hazard Mitigation Plans

Strengths, Biases and Limitations of Methodology 1

This summary of local hazard mitigation plan risk assessments shows strong consistency with other parts of this section, i.e. that coastal Counties and those with the highest populations appear to have the most projected future damages (risk), based on the calculations in the plans. The validity of these individual studies has not been verified, except insofar as the plans were reviewed and approved by AEMA and FEMA. As hazard mitigation planning matures and the local plans are reviewed and updated over time, the risk assessment methodologies and results will improve, although even in their present state they appear consistent with other results, suggesting that the existing determinations are likely to be relatively accurate.

Methodology 2 - FEMA Public Assistance Program Project Worksheet Data from Recent Disasters in the State

From 2002 to 2006, Alabama has experienced a number of significant natural hazard events, seven of which resulted in Presidential disaster declarations. These disasters, summarized in **Table 5.5-3** below, all had FEMA Public Assistance (PA) components.

Table 5.5-3
Recent Federal Disaster Declarations in Alabama

Date	Type of Incident	Disaster Declaration #
October 9, 2002	Tropical Storm Isidore	1438
November 14, 2002	Severe Storm, Tornado	1442
May 12, 2003	Severe Storm, Thunderstorms, Tornado, Flooding	1466
September 15, 2004	Hurricane Ivan	1549
July 10, 2005	Hurricane Dennis	1593
August 29, 2005	Hurricane Katrina	1605
March 1, 2007*	Severe Storms and Tornados	1687

Source: Federal Emergency Management Agency
*Note: Data from this disaster is not included in this risk assessment

At the request of AEMA, FEMA provided a database of requested amounts for various categories of public assistance (PA). Although the data were not well differentiated in terms of the kinds of damage or the facilities that were damaged, it did provide an overall indication of the relative amounts requested and the locations. **Table 5.5-4** below is a summary of this information. Note that the dollar figures included are “requested” or “eligible” amounts, not necessarily the exact amounts that FEMA provided through grants. Nevertheless, because the worksheets are strictly related to public facilities, the data offers another perspective on historic damages in the State.

Table 5.5-4
Summary of Project Worksheet Figures from Six Recent Alabama Disasters

County	Eligible Project Worksheet Amount
Baldwin	$292,888,649
Mobile	$96,433,427
Jefferson	$22,224,186
Clarke	$17,155,490
Walker	$9,759,712
Wilcox	$8,290,891

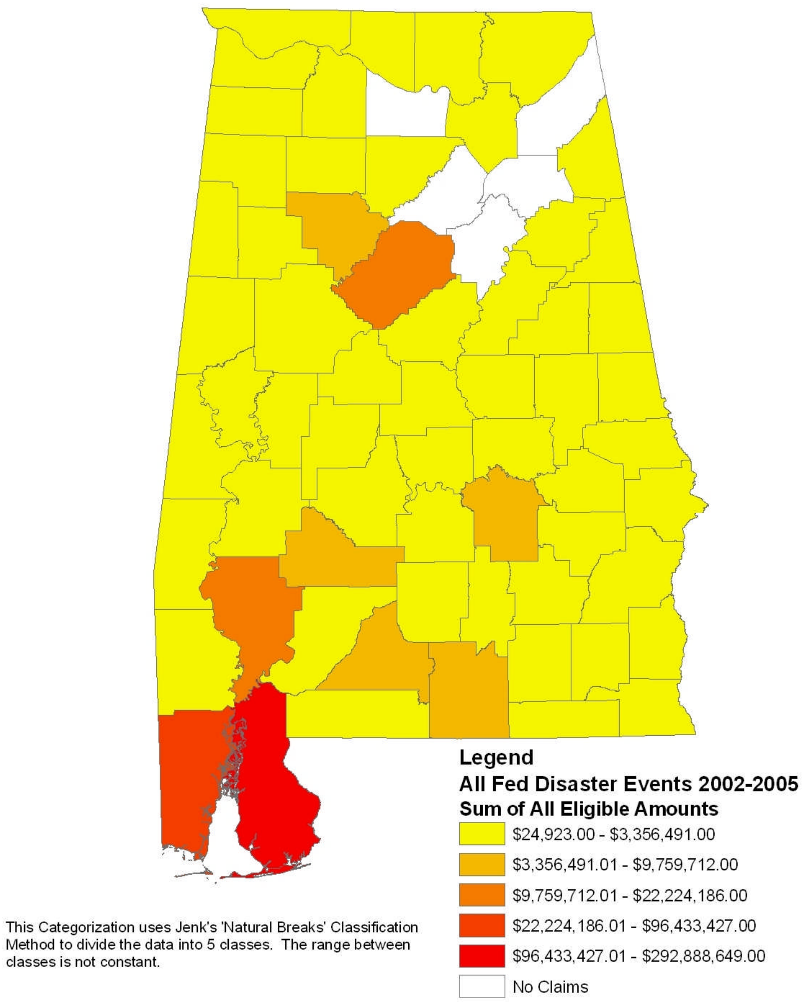
Table 5.5-4
Summary of Project Worksheet Figures from Six Recent Alabama Disasters

County	Eligible Project Worksheet Amount
Covington	$6,293,752
Conecuh	$5,029,948
Montgomery	$4,535,092
Fayette	$3,356,491
Escambia	$2,992,574
Cullman	$2,956,858
Tuscaloosa	$2,807,640
Dallas	$2,624,505
Crenshaw	$2,403,687
Randolph	$2,086,841
Cherokee	$1,912,602
Butler	$1,705,647
Marengo	$1,621,129
Talladega	$1,452,252
Houston	$1,400,683
Washington	$1,387,957
Jackson	$1,336,657
Monroe	$1,335,292
Lauderdale	$1,323,846
Colbert	$1,296,443
Lee	$1,270,494
Madison	$1,160,952
Dale	$1,079,152
Pike	$933,398
Russell	$917,800
Coffee	$811,993
Cleburne	$804,182
Geneva	$771,312
Elmore	$644,851
Perry	$621,829
Chambers	$620,013
Choctaw	$588,740
Shelby	$579,725
Marion	$558,657
Sumter	$463,731
Limestone	$452,580
Franklin	$426,720
Tallapoosa	$409,010
Greene	$405,034
Clay	$396,354
Autauga	$389,720
Henry	$382,356
Lamar	$372,948
Marshall	$363,875
Pickens	$289,219
Hale	$279,974
Bibb	$233,918
Lowndes	$225,503

Table 5.5-4
Summary of Project Worksheet Figures from Six Recent Alabama Disasters

County	Eligible Project Worksheet Amount
Chilton	$205,184
Coosa	$203,061
Macon	$201,694
Winston	$180,362
Calhoun	$126,657
Lawrence	$111,102
Bullock	$88,981
Barbour	$24,923
Total	**$514,208,255**

Figure 5.5-6
Public Assistance Project Worksheet Claims from Recent Alabama Disasters
Source: FEMA



5.5.2 Flood Risk

Floods are the most extensively studied natural hazard in most parts of the U.S. For most areas of moderate or greater population density and known flooding, detailed flood studies exist that show where floodwaters are likely to go and the frequency with which they are likely to occur. There is also an array of empirical data about the damages floods have caused in many areas. There are also various sources of information about how many people and structures are located in various areas. This information can be obtained from U.S. Census reports. These three sources of information were all used in determining statewide risk from floods. The techniques used and the results are discussed in the paragraphs below.

5.5.2.1 Summary of Local Risk Assessments

Potential loss estimates from local hazard mitigation plans can be found in **Section 5.5.1**.

5.5.2.2 Statewide Risk Assessment

Because of the availability of data, four separate methods were used to estimate flood risk Statewide. These are discussed in turn below. Although statistical corroboration was not possible because of the nature of the data, the combination of methods was to provide a broader range of information to better characterize the flood risk.

Methodology 1 – Analysis of NFIP Claims Data

This method is based on a straightforward analysis of historic National Flood Insurance Program claims data across Alabama. **Table 5.5-5** shows the history of flood insurance claims in the State, from 1978 to 2007. Note that the table does not include Clay and Perry Counties because this information was not in the database. Most of the columns are self-explanatory. The risk estimate (Column H) was determined using the average annual losses per county and multiplying the figure by the standard present value coefficient for a 7 percent discount rate (required by OMB) over a 30 year horizon.

Key to Table Columns:

A. Number of flood insurance policies;
B. Number of flood insurance claims;
C. Number of claims per policy;
D. Total dollar value amount of all claims;
E. Number of Claims per year;
F. Average dollar value amount per claim;
G. Average annual number of claims County-wide; and
H. Total risk projection over a 30 year horizon.

Table 5.5-5
Summary of Flood Insurance Claims Statistics for Alabama Counties (Updated)

County	A	B	C	D	E	F	G	H
Baldwin County	25,709	16,140	0.63	$494,039,794	556.55	$30,610	$17,035,855	$211,414,960
Mobile County	10,491	13,637	1.30	$340,852,033	470.24	$24,995	$11,753,518	$145,861,163
Jefferson County	3,155	1,855	0.59	$20,940,771	63.97	$11,289	$722,096	$8,961,206
Coffee County	389	486	1.25	$15,019,441	16.76	$30,904	$517,912	$6,427,285
Escambia County	192	223	1.16	$7,030,377	7.69	$31,526	$242,427	$3,008,517
Madison County	3,150	496	0.16	$6,256,579	17.10	$12,614	$215,744	$2,677,384
Shelby County	700	490	0.70	$5,479,834	16.90	$11,183	$188,960	$2,344,991
Dale County	352	156	0.44	$3,705,291	5.38	$23,752	$127,769	$1,585,609
Autauga County	1,769	212	0.12	$2,400,027	7.31	$11,321	$82,760	$1,027,046
Geneva County	133	112	0.84	$2,079,052	3.86	$18,563	$71,691	$889,691
Elmore County	2,001	178	0.09	$1,830,729	6.14	$10,285	$63,129	$783,426
Montgomery County	1,904	180	0.09	$1,784,271	6.21	$9,913	$61,527	$763,545
Lowndes County	1,673	167	0.10	$1,699,017	5.76	$10,174	$58,587	$727,062
Dallas County	457	165	0.36	$1,402,942	5.69	$8,503	$48,377	$600,362
Houston County	334	78	0.23	$1,243,819	2.69	$15,946	$42,890	$532,269
St. Clair County	441	104	0.24	$1,055,706	3.59	$10,151	$36,404	$451,769
Tuscaloosa County	768	111	0.14	$883,950	3.83	$7,964	$30,481	$378,270
Colbert County	165	93	0.56	$858,521	3.21	$9,231	$29,604	$367,388
Morgan County	953	82	0.09	$819,972	2.83	$10,000	$28,275	$350,891
Lauderdale County	11	106	9.64	$788,144	3.66	$7,435	$27,177	$337,271
Greene County	119	132	1.11	$675,185	4.55	$5,115	$23,282	$288,933
Chambers County	46	11	0.24	$666,181	0.38	$60,562	$22,972	$285,080
Blount County	18	20	1.11	$557,562	0.69	$27,878	$19,226	$238,598
Etowah County	468	83	0.18	$515,386	2.86	$6,209	$17,772	$220,550
Pickens County	85	80	0.94	$500,523	2.76	$6,257	$17,259	$214,189
Covington County	91	36	0.40	$416,536	1.24	$11,570	$14,363	$178,249
Hale County	128	110	0.86	$377,415	3.79	$3,431	$13,014	$161,508
Calhoun County	453	86	0.19	$348,823	2.97	$4,056	$12,028	$149,272
DeKalb County	69	22	0.32	$311,755	0.76	$14,171	$10,750	$133,410
Jackson County	193	35	0.18	$272,048	1.21	$7,773	$9,381	$116,418
Choctaw County	40	40	1.00	$244,699	1.38	$6,117	$8,438	$104,714
Marshall County	50	7	0.14	$228,307	0.24	$32,615	$7,873	$97,700
Talladega County	419	49	0.12	$196,855	1.69	$4,017	$6,788	$84,240
Lawrence County	180	19	0.11	$157,898	0.66	$8,310	$5,445	$67,569
Limestone County	146	39	0.27	$156,083	1.34	$4,002	$5,382	$66,793
Marion County	15	16	1.07	$148,078	0.55	$9,255	$5,106	$63,367
Monroe County	32	30	0.94	$111,282	1.03	$3,709	$3,837	$47,621
Sumter County	41	10	0.24	$111,222	0.34	$11,122	$3,835	$47,595

Table 5.5-5
Summary of Flood Insurance Claims Statistics for Alabama Counties (Updated)

County	A	B	C	D	E	F	G	H
Washington County	21	14	0.67	$103,893	0.48	$7,421	$3,583	$44,459
Lee County	110	28	0.25	$85,659	0.97	$3,059	$2,954	$36,656
Lamar County	11	13	1.18	$74,653	0.45	$5,743	$2,574	$31,946
Walker County	129	11	0.09	$64,197	0.38	$5,836	$2,214	$27,472
Crenshaw County	6	1	0.17	$63,306	0.03	$63,306	$2,183	$27,091
Chilton County	27	5	0.19	$51,944	0.17	$10,389	$1,791	$22,228
Wilcox County	41	15	0.37	$51,856	0.52	$3,457	$1,788	$22,191
Barbour County	34	23	0.68	$49,106	0.79	$2,135	$1,693	$21,014
Coosa County	18	4	0.22	$48,435	0.14	$12,109	$1,670	$20,727
Henry County	17	4	0.24	$33,975	0.14	$8,494	$1,172	$14,539
Russell County	77	17	0.22	$28,932	0.59	$1,702	$998	$12,381
Marengo County	75	18	0.24	$25,550	0.62	$1,419	$881	$10,934
Cherokee County	163	4	0.02	$22,709	0.14	$5,677	$783	$9,718
Tallapoosa County	24	2	0.08	$19,024	0.07	$9,512	$656	$8,141
Cullman County	42	3	0.07	$17,270	0.10	$5,757	$596	$7,390
Conecuh County	2	1	0.50	$6,624	0.03	$6,624	$228	$2,835
Clarke County	13	2	0.15	$1,941	0.07	$971	$67	$831
Bullock County	7	1	0.14	$654	0.03	$654	$23	$280
Bibb County	19	2	0.11	$0	0.07	$0	$0	$0
Butler County	11	0	0.00	$0	0.00	$0	$0	$0
Cleburne County	1	0	0.00	$0	0.00	$0	$0	$0
Fayette County	16	0	0.00	$0	0.00	$0	$0	$0
Franklin County	13	0	0.00	$0	0.00	$0	$0	$0
Macon County	18	0	0.00	$0	0.00	$0	$0	$0
Pike County	12	0	0.00	$0	0.00	$0	$0	$0
Randolph County	16	0	0.00	$0	0.00	$0	$0	$0
Winston County	40	0	0.00	$0	0.00	$0	$0	$0
Statewide	**58,303**	**36,064**		**$916,915,836**	**1243.59**		**$31,617,787**	**$392,376,742**

Source: FEMA Region IV NFIP Query

The pattern that emerges in this analysis of claims is similar to that in the other assessment methodologies, i.e. coastal counties and those with relatively high populations are the most at risk in the State. Certain other results may be interesting as points of analysis (aside from the total number and amount of claims), such as the number of claims per policy and the average amount of claims in particular counties.

Table 5.5-6
NFIP Statewide Claims Data Summary (Updated)

Data	Value
Number of claims in database	36,064
Sum of claims (2007 query)	$916,915,836
Average annual damages Statewide	$31,617,787
Flood risk (30-year horizon)	$392,376,742

Table 5.5-7
NFIP Claims Data Analysis: Selected Parameters (Updated)

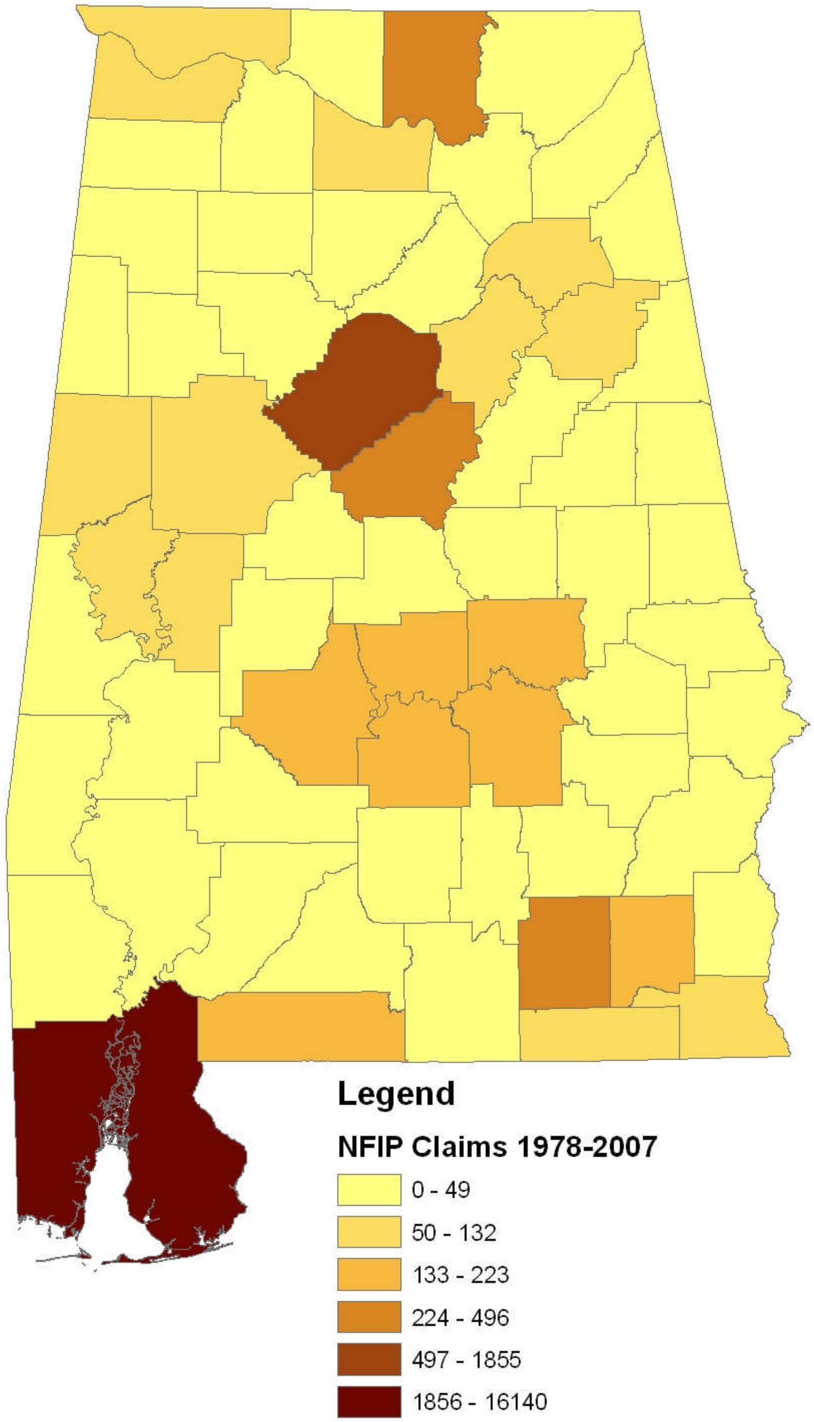
Parameter	Past Damages	Future Risk
Highest risk (Baldwin)	$494,039,794	$211,414,960
Average risk	$13,685,311	$5,856,369
Median risk (Talladega)	$196,855	$84,240

Tables 5.5-5 thru **5.5-7** demonstrate a significant skew created by Mobile, Baldwin and Jefferson Counties, a pattern that is evident in most of the other analyses in this section. This is likely a result of relatively high populations in these areas, in the case of the coastal counties combined with exposure to the effects of hurricanes and tropical storms from the Gulf of Mexico.

Strengths, Biases and Limitations of Methodology 1

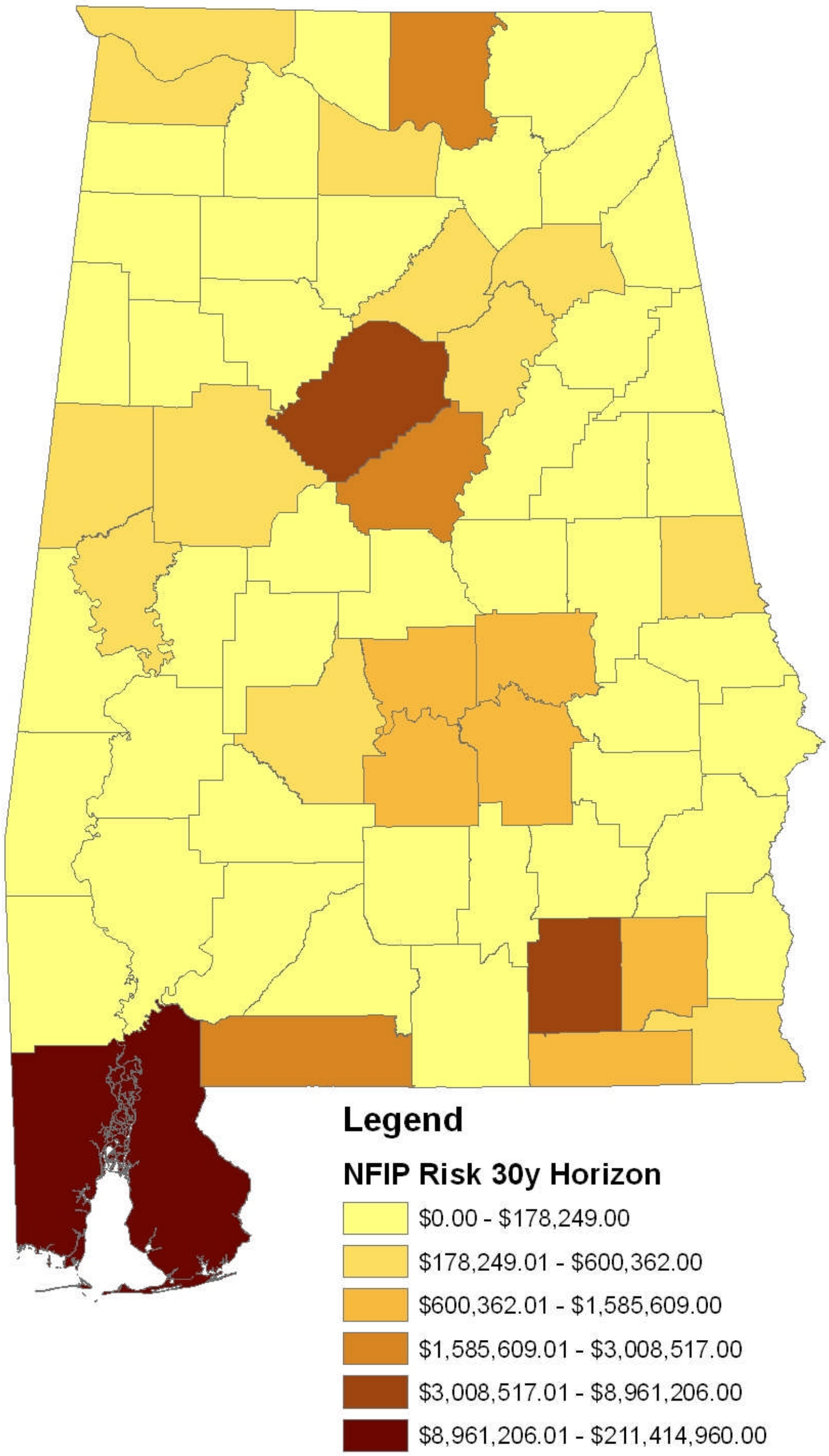
This analysis uses FEMA/NFIP flood insurance claim data obtained from FEMA Region IV in May 2007. The data include a large enough sample over a sufficient period of time to be statistically reliable for the purpose of assessing relative flood risk statewide. This data cannot be considered a pure indication of risk because the repetitive loss properties are identified via insurance claims, so risk to uninsured property is not represented in the data. The raw numbers of properties in the tables above also do not address the issue of flood risk at individual insured sites because data is aggregated to the county level.

Figure 5.5-7
Number of NFIP Claims in Alabama,
1974-2007 (Updated)



Source: FEMA/National Flood Insurance Program

Figure 5.5-8
Total 30-year Risk Projection Developed from NFIP Claim Analysis, 1974-2007 (Updated)



Source: FEMA/National Flood Insurance Program

Methodology 2 – Analysis of NFIP Repetitive Loss Claims Data

The second flood risk assessment method is based on National Flood Insurance Program (NFIP) repetitive loss insurance claims over a period of about 29 years (the data begins in 1978). The claims information was obtained from FEMA Region IV in May 2007. The data were sorted into counties, and then sorted again to count both the numbers of claims over the period and the amount of claims in dollars. These figures were then each divided by the reporting period to determine an annual number of claims and dollar losses (**Table 5.5-8**). This is the annualized figure discussed in the previous section on risk definitions. The annualized dollar loss figure was then projected out 30 years using the FEMA present-value coefficient from the benefit-cost-analysis software. Use of the present value coefficient performs the discounting required by OMB Circular No. A-94 guidance. The 7 percent figure was current at the time this plan was produced and had been in effect for more than 10 years prior.

Table 5.5-8
Summary of Key Repetitive Loss Claims Statistics for Alabama Counties

County Name	Totals by County 1978-2007			Averages by County			County Annual $	Risk (30 years)
	Policies	Claims	$ Amount	Claim	$/policy	Ann #		
Baldwin	2,164	5,892	$247,139,764	$41,945	$114,205	235.68	$9,885,591	$122,680,179
Mobile	1,959	5,450	$188,796,382	$34,642	$96,374	155.71	$5,394,182	$66,941,803
Jefferson	209	562	$9,358,023	$16,651	$44,775	16.06	$267,372	$3,318,087
Escambia	37	98	$5,317,658	$54,262	$143,720	2.80	$151,933	$1,885,490
Shelby	85	290	$4,278,994	$14,755	$50,341	8.29	$122,257	$1,517,209
Coffee	48	109	$2,465,065	$22,615	$51,356	3.11	$70,430	$874,042
Dale	15	32	$1,582,347	$49,448	$105,490	0.91	$45,210	$561,055
Geneva	12	27	$903,107	$33,448	$75,259	0.77	$25,803	$320,216
Montgomery	12	35	$808,756	$23,107	$67,396	1.00	$23,107	$286,762
Colbert	11	32	$530,844	$16,589	$48,259	0.91	$15,167	$188,222
Lauderdale	19	55	$526,819	$9,579	$27,727	1.57	$15,052	$186,795
Houston	7	16	$479,291	$29,956	$68,470	0.46	$13,694	$169,943
Tuscaloosa	9	21	$468,984	$22,333	$52,109	0.60	$13,400	$166,288
Greene	23	59	$437,441	$7,414	$19,019	1.69	$12,498	$155,104
Morgan	4	19	$380,076	$20,004	$95,019	0.54	$10,859	$134,764
Madison	16	44	$351,803	$7,996	$21,988	1.26	$10,052	$124,739
Autauga	4	14	$337,304	$24,093	$84,326	0.40	$9,637	$119,598
Pickens	13	38	$317,131	$8,346	$24,395	1.09	$9,061	$112,445
Etowah	11	24	$254,175	$10,591	$23,107	0.69	$7,262	$90,123
Covington	6	12	$214,163	$17,847	$35,694	0.34	$6,119	$75,936
Dallas	7	19	$206,932	$10,891	$29,562	0.54	$5,912	$73,372
DeKalb	4	11	$164,089	$14,917	$41,022	0.31	$4,688	$58,181
Blount	2	7	$129,888	$18,555	$64,944	0.20	$3,711	$46,055
Hale	15	34	$110,861	$3,261	$7,391	0.97	$3,167	$39,308
Lawrence	4	10	$108,256	$10,826	$27,064	0.29	$3,093	$38,384
St. Clair	2	4	$102,511	$25,628	$51,256	0.11	$2,929	$36,348
Marion	3	7	$66,224	$9,461	$22,075	0.20	$1,892	$23,481
Limestone	5	12	$65,570	$5,464	$13,114	0.34	$1,873	$23,249
Choctaw	3	8	$63,612	$7,952	$21,204	0.23	$1,817	$22,555
Calhoun	5	13	$129,888	$3,871	$10,066	0.37	$1,438	$17,845
Jackson	2	6	$49,738	$8,290	$24,869	0.17	$1,421	$17,636
Chambers	1	2	$13,651	$12,075	$24,151	0.06	$690	$8,563

Table 5.5-8
Summary of Key Repetitive Loss Claims Statistics for Alabama Counties

County Name	Totals by County 1978-2007			Averages by County			County Annual $	Risk (30 years)
	Policies	Claims	$ Amount	Claim	$/policy	Ann #		
Lee	3	9	$13,672	$2,364	$7,093	0.26	$608	$7,545
Lamar	1	2	$102,511	$8,697	$17,395	0.06	$497	$6,168
Talladega	2	4	$13,590	$3,418	$6,836	0.11	$391	$4,848
Walker	2	4	$6,250	$3,413	$6,826	0.11	$390	$4,840
Russell	2	4	$12,473	$3,398	$6,795	0.11	$388	$4,819
Wilcox	1	2	$8,891	$6,236	$12,473	0.06	$356	$4,422
Washington	1	2	$4,057	$4,446	$8,891	0.06	$254	$3,153
Monroe	2	4	$17,395	$1,562	$3,125	0.11	$179	$2,216
Sumter	1	2	$24,151	$2,028	$4,057	0.06	$116	$1,438
Winston	0	0	$0	$0	$0	0.00	$0	$0
Tallapoosa	0	0	$0	$0	$0	0.00	$0	$0
Randolph	0	0	$0	$0	$0	0.00	$0	$0
Pike	0	0	$0	$0	$0	0.00	$0	$0
Perry	0	0	$0	$0	$0	0.00	$0	$0
Marshall	0	0	$0	$0	$0	0.00	$0	$0
Marengo	0	0	$0	$0	$0	0.00	$0	$0
Macon	0	0	$0	$0	$0	0.00	$0	$0
Lowndes	0	0	$0	$0	$0	0.00	$0	$0
Henry	0	0	$0	$0	$0	0.00	$0	$0
Franklin	0	0	$0	$0	$0	0.00	$0	$0
Fayette	0	0	$0	$0	$0	0.00	$0	$0
Elmore	0	0	$0	$0	$0	0.00	$0	$0
Cullman	0	0	$0	$0	$0	0.00	$0	$0
Crenshaw	0	0	$0	$0	$0	0.00	$0	$0
Coosa	0	0	$0	$0	$0	0.00	$0	$0
Conecuh	0	0	$0	$0	$0	0.00	$0	$0
Cleburne	0	0	$0	$0	$0	0.00	$0	$0
Clay	0	0	$0	$0	$0	0.00	$0	$0
Clarke	0	0	$0	$0	$0	0.00	$0	$0
Chilton	0	0	$0	$0	$0	0.00	$0	$0
Cherokee	0	0	$0	$0	$0	0.00	$0	$0
Butler	0	0	$0	$0	$0	0.00	$0	$0
Bullock	0	0	$0	$0	$0	0.00	$0	$0
Bibb	0	0	$0	$0	$0	0.00	$0	$0
Barbour	0	0	$0	$0	$0	0.00	$0	$0
Totals:	**4,732**	**12,995**	**$466,201,545**	**$35,875**	**$98,521**	**448.1**	**$16,144,499**	**$200,353,228**

Source: FEMA Region IV NFIP Query

The analysis produced the predicted result: coastal counties and counties with the highest populations (i.e. Jefferson) have the most risk. Although the cumulative risk column (far right) indicates the counties that appear to have the most potential for future flood losses, other data can also be useful indicators of more localized risks (although the data used in the analysis do not include specific addresses). For example, areas with the highest per-claim average may suggest that either flood depths or structure/contents values are above the statewide average. This information can be used to identify the most appropriate mitigation methods. The tables and figures below show the data in various configurations.

Table 5.5-9
NFIP Repetitive Loss Data Analysis Statewide Summary

Data	Value
Number of claims in database	12,995
Sum of claims (2007 query)	$466,201,545
Average annual damages Statewide	$13,320,044
Repetitive loss flood risk (30-year horizon)	$200,353,228

Table 5.5-10
NFIP Repetitive Loss Data Analysis: Selected Parameters

Parameter	Past Damages	Future Risk
Highest risk (Baldwin)	$218,284,030	$122,680,179
Average risk	$5,503,303	$2,990,347
Median risk (Talladega)	$11,400	$4,848

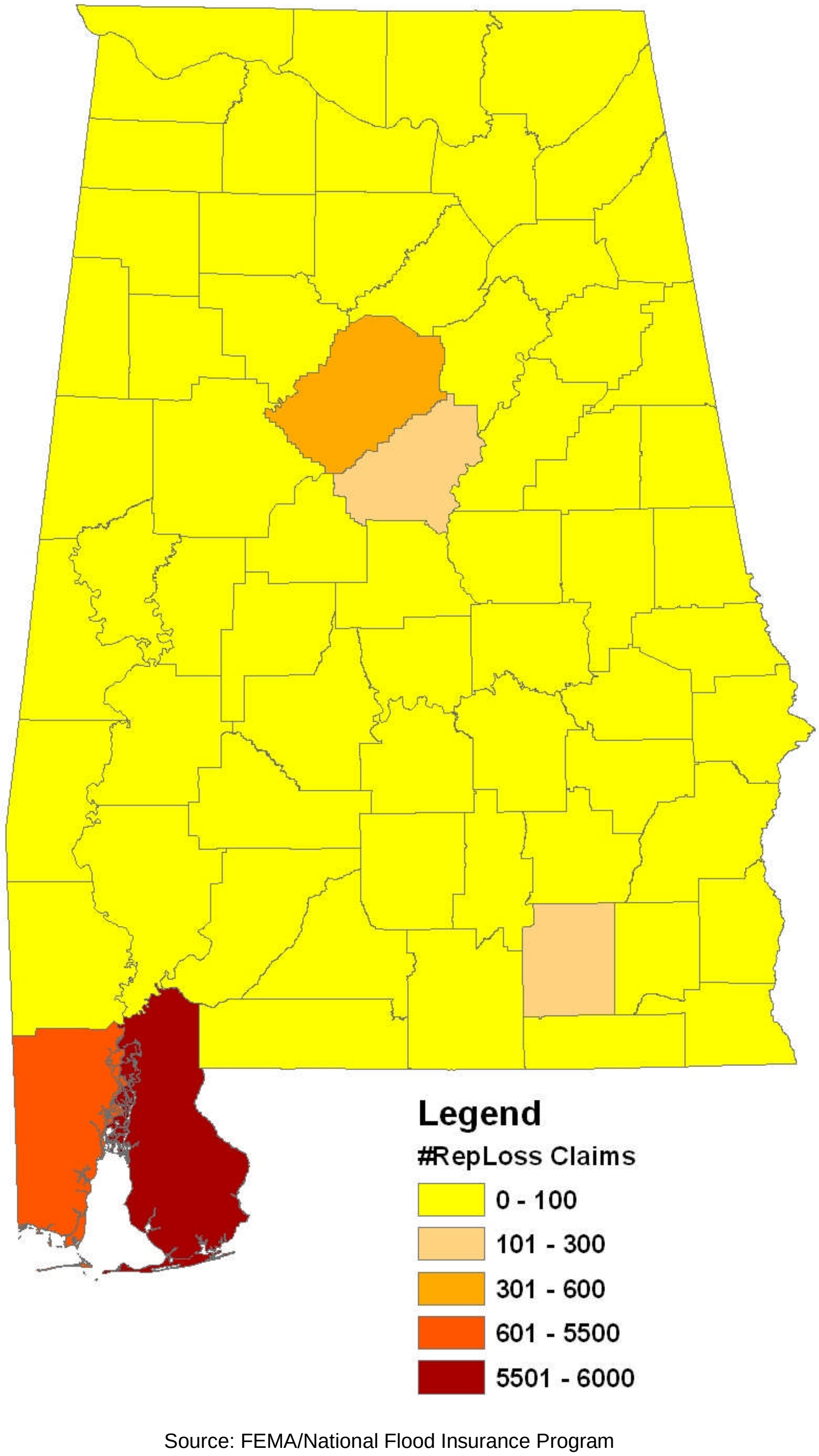
The results of this methodology mirror the pattern in the other analyses, i.e. that Baldwin and Mobile Counties have the greatest flood risk. The repetitive loss data are a subset of the general NFIP claims data, so it is expected that this pattern would hold between the two analyses.

Strengths, Biases and Limitations of Methodology 2

This analysis uses FEMA/NFIP repetitive loss flood claim data obtained from FEMA Region IV in May 2007. The data includes a large enough sample over a sufficient period of time to be statistically reliable for the purpose of assessing relative flood risk Statewide. The criteria for determining which properties qualify as repetitive loss status naturally introduces certain biases into the resulting data. This data cannot be considered a pure indication of risk because the repetitive loss properties are identified via insurance claims, so risk to uninsured property is not represented in the data. The raw numbers of properties in the table above also do not address the issue of flood risk at individual insured sites because data is aggregated to the county level.

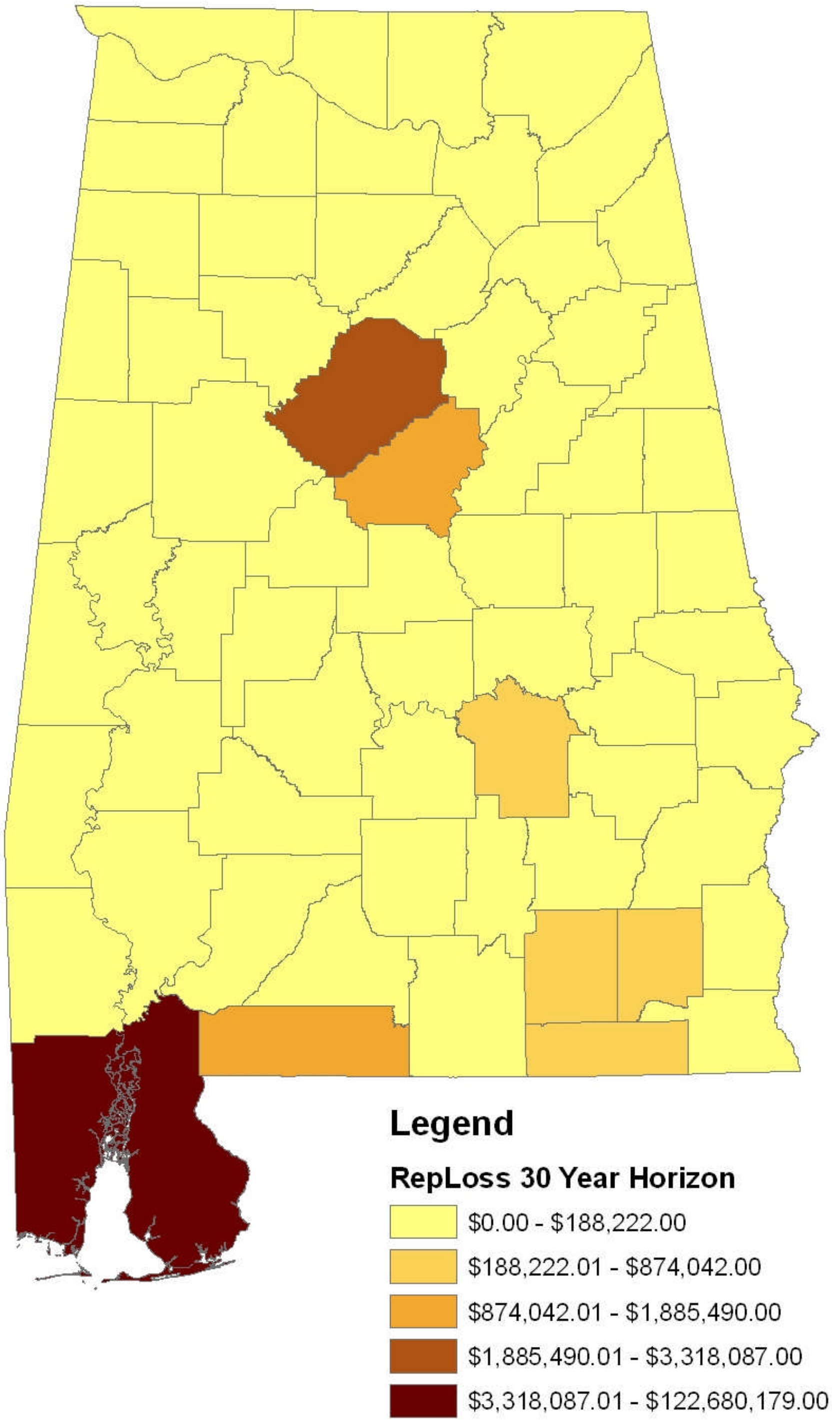
The data can, however, provide insight into the relative flood risk in the State, accepting the bias noted previously. The concentrations of repetitive loss properties in certain counties suggests that further study should be undertaken in these areas to determine if mitigation actions are indicated. This risk index is particularly important in the context of FEMA grant programs because the Agency has established explicit goals related to mitigation actions at such properties.

Figure 5.5-9
Number of NFIP Repetitive Loss Claims in Alabama, 1974-2007 (Updated)



Source: FEMA/National Flood Insurance Program

Figure 5.5-10
Total 30-year Risk Projection Based on Analysis of NFIP Repetitive Loss Claim Analysis



Source: FEMA/National Flood Insurance Program

Methodology 3 – GIS Analysis of Census Data and Digital Flood Maps

Note: Census data regarding population and Q3 floodplain boundary coverage have not changed since the 2004 version of the Plan, so this information is considered still valid and the discussion has not changed from the initial Plan.

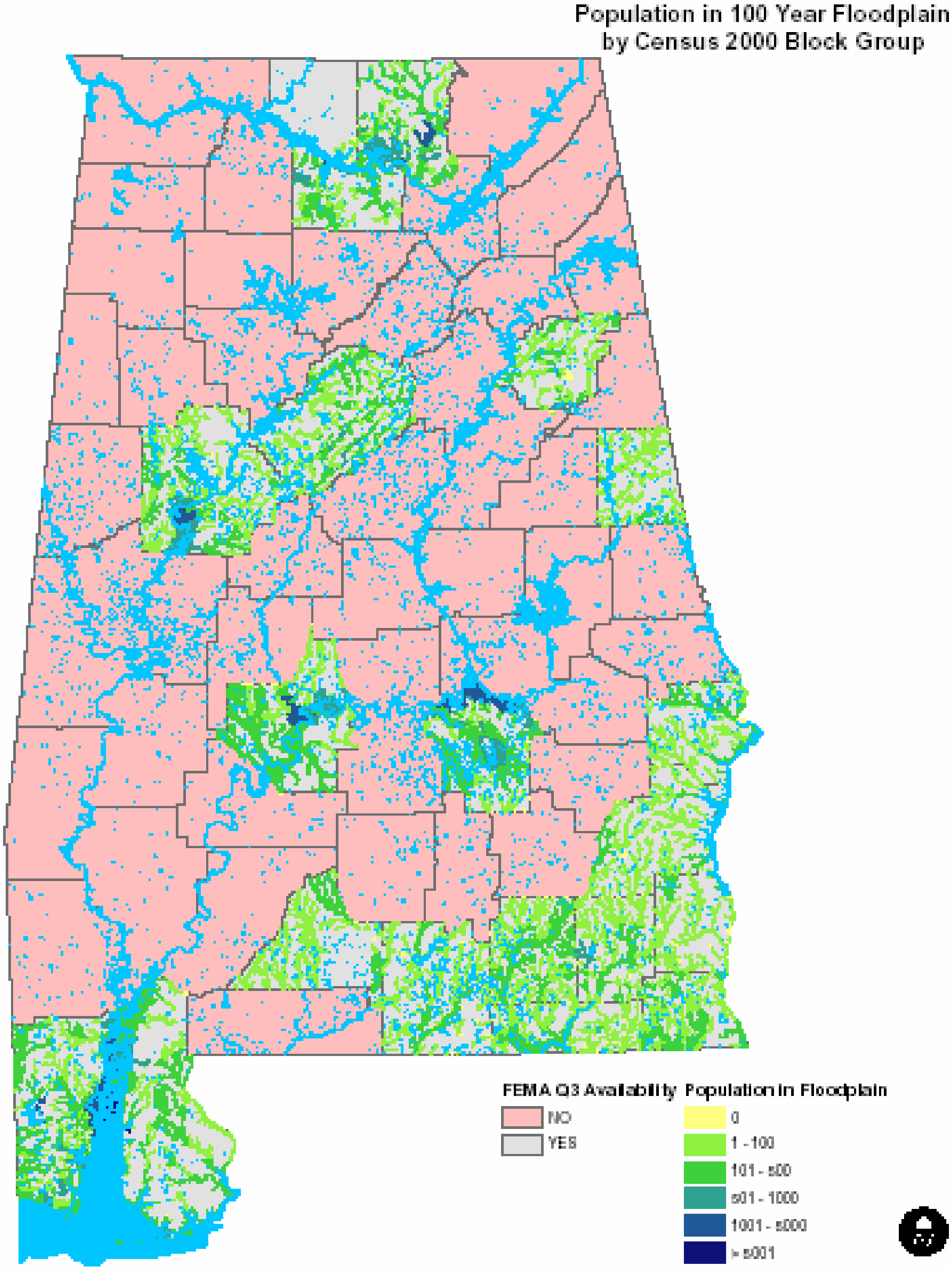
The third method is based on a process in which U.S. census block population data is overlaid on base maps that show the boundaries of the 100-year floodplain, from FEMA flood hazard boundary maps (also known as *Q3* maps.) This method shows the percentage of each census block group that is in the floodplain. This information can then be used to infer the number of people and structures that are exposed to flooding. Although the information used in the initial analysis is at a block group level, the data can easily be converted to county level to be compared to the results of the other risk assessment methodologies.

Table 5.5-11
Population in 100-year Floodplain by County

County	Population in 100-year Floodplain
Mobile	49,550
Jefferson	46,579
Montgomery	39,028
Madison	30,910
Tuscaloosa	23,563
Baldwin	19,286
Morgan	15,748
Dallas	13,088
Calhoun	9,780
Houston	6,933
Russell	4,541
Coffee	4,313
Dale	4,298
Barbour	3,694
Geneva	3,110
Covington	2,682
Randolph	1,359
Henry	1,157

Note that this table of Counties is limited to 19 because only these Counties had Q3 floodplain maps available. This list should be updated as part of the plan maintenance process, as new maps become available.

Figure 5.5-11
Alabama Population in 100-year Floodplain, Graphical Depiction



Source: U.S. Census 2000, FEMA.

Strengths, Biases and Limitations of Methodology 3

This method is based on data considered reliable because it comes from public sources such as the U.S. Census and FEMA floodplain maps. The method provides a reasonable way to correlate the other hazard and risk data obtained in Methods 1 and 2, but should not be considered reliable as an independent method to calculate risk. Although the data underlying the census block group figures can be considered reliable, the exact distribution of people and structures within the individual block group areas is not known. As noted above, GIS technology was used to calculate the percentage of individual block groups that are in the flood plain. This method assumes that populations and structures are evenly distributed across block groups. The accuracy of this assumption cannot be tested within the scope of this plan, but presumably some block groups and counties will have higher than expected densities of people and structures in the floodplain, and some will have lower densities.

Also note that only 19 of 67 counties in the State had Q3 maps available, so the entire State is not represented in this method. Where possible, the results were used to corroborate flood risk calculations from the other methods, but this was obviously not available in all counties.

Methodology 4 – Analysis of FEMA HAZUS-MH Data

HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). NIBS maintains committees of wind, flood, earthquake and software experts to provide technical oversight and guidance to HAZUS-MH development. Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods, and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing mitigation plans and policies, emergency preparedness, and response and recovery planning.

HAZUS-MH provides estimates of hazard-related damage before a disaster occurs and takes into account various impacts of a hazard event. The impacts include the following:

- Physical damage – damage to residential and commercial buildings, schools, critical facilities and infrastructure.
- Economic loss – lost jobs, business interruptions, repair and reconstruction costs.
- Social impacts – impacts to people, including requirements for shelters and medical aid.

HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods, and earthquakes on populations. HAZUS-MH will be fast-running to facilitate use in real time to support response and recovery following a natural disaster.
HAZUS-MH provides for three levels of analysis:

- A Level 1 analysis yields a rough estimate based on the nationwide database and is a great way to begin the risk assessment process and prioritize high-risk communities.

- A Level 2 analysis requires the input of additional or refined data and hazard maps that will produce more accurate risk and loss estimates. Assistance from local emergency management personnel, city planners, GIS professionals, and others may be necessary for this level of analysis.

- A Level 3 analysis yields the most accurate estimate of loss and typically requires the involvement of technical experts such as structural and geotechnical engineers who can modify loss parameters based on to the specific conditions of a community. This level analysis will allow users to supply their own techniques to study special conditions such as dam breaks and tsunamis. Engineering and other expertise are needed at this level.

Three data input tools have been developed to support data collection. The Inventory Collection Tool (InCAST) helps users collect and manage local building data for more refined analyses than are possible with the national level data sets that come with HAZUS. InCAST was released in 2002 with expanded capabilities for multi-hazard data collection. HAZUS-MH includes an enhanced Building Inventory Tool (BIT) allows users to import building data and is most useful when handling large datasets (over 100,000 records), such as tax assessor records. The Flood Information Tool (FIT) helps users manipulate flood data into the format required by the HAZUS flood model.

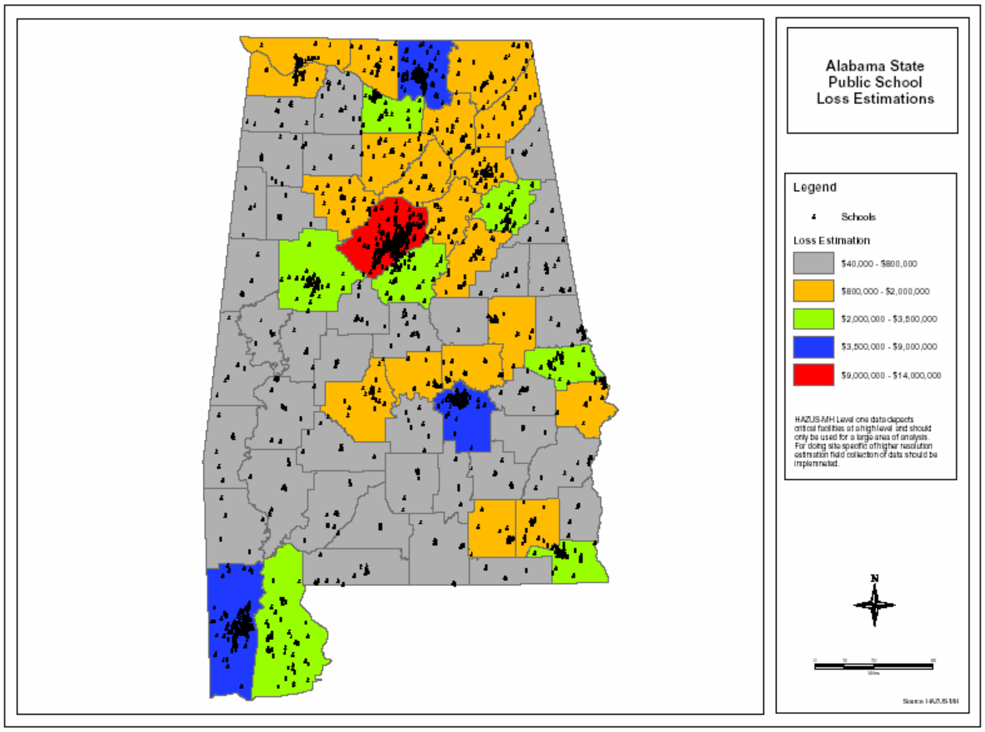
Table 5.5-12
Flood Risk to Selected Alabama Critical Facilities based on FEMA HAZUS Data

County	Police	Schools	Fire	EOCs	Total	% of Total
Jefferson	$1,790,208	$13,677,118	$1,054,944	$0	$16,522,270	13.82%
Mobile	$857,808	$8,954,533	$511,488	$0	$10,323,829	8.63%
Madison	$522,144	$5,598,130	$335,664	$26,640	$6,482,578	5.42%
Montgomery	$447,552	$4,702,339	$175,824	$26,640	$5,352,355	4.48%
Tuscaloosa	$410,256	$3,326,596	$271,728	$0	$4,008,580	3.35%
Baldwin	$596,736	$2,779,493	$383,616	$26,640	$3,786,485	3.17%
Shelby	$410,256	$2,639,231	$383,616	$0	$3,433,103	2.87%
Morgan	$447,552	$2,196,959	$303,696	$0	$2,948,207	2.47%
Calhoun	$298,368	$2,170,864	$351,648	$0	$2,820,880	2.36%
Etowah	$522,144	$1,918,684	$271,728	$26,640	$2,739,196	2.29%
Houston	$372,960	$2,093,478	$175,824	$0	$2,642,262	2.21%
Lee	$149,184	$2,075,481	$111,888	$53,280	$2,389,833	2.00%
Marshall	$372,960	$1,670,890	$335,664	$0	$2,379,514	1.99%
Lauderdale	$335,664	$1,658,293	$303,696	$0	$2,297,653	1.92%
Talladega	$298,368	$1,505,545	$255,744	$26,640	$2,086,297	1.74%
Elmore	$223,776	$1,516,343	$287,712	$0	$2,027,831	1.70%
Walker	$410,256	$1,245,716	$255,744	$26,640	$1,938,356	1.62%
DeKalb	$522,144	$1,153,032	$255,744	$0	$1,930,920	1.61%
St. Clair	$372,960	$1,309,942	$207,792	$0	$1,890,694	1.58%
Cullman	$186,480	$1,479,674	$191,808	$26,640	$1,884,602	1.58%
Jackson	$261,072	$1,096,455	$239,760	$53,280	$1,650,567	1.38%
Limestone	$149,184	$1,290,371	$207,792	$0	$1,647,347	1.38%
Colbert	$261,072	$987,349	$191,808	$0	$1,440,229	1.20%
Dallas	$74,592	$1,184,189	$175,824	$0	$1,434,605	1.20%
Dale	$298,368	$972,277	$95,904	$0	$1,366,549	1.14%

Table 5.5-12
Flood Risk to Selected Alabama Critical Facilities based on FEMA HAZUS Data

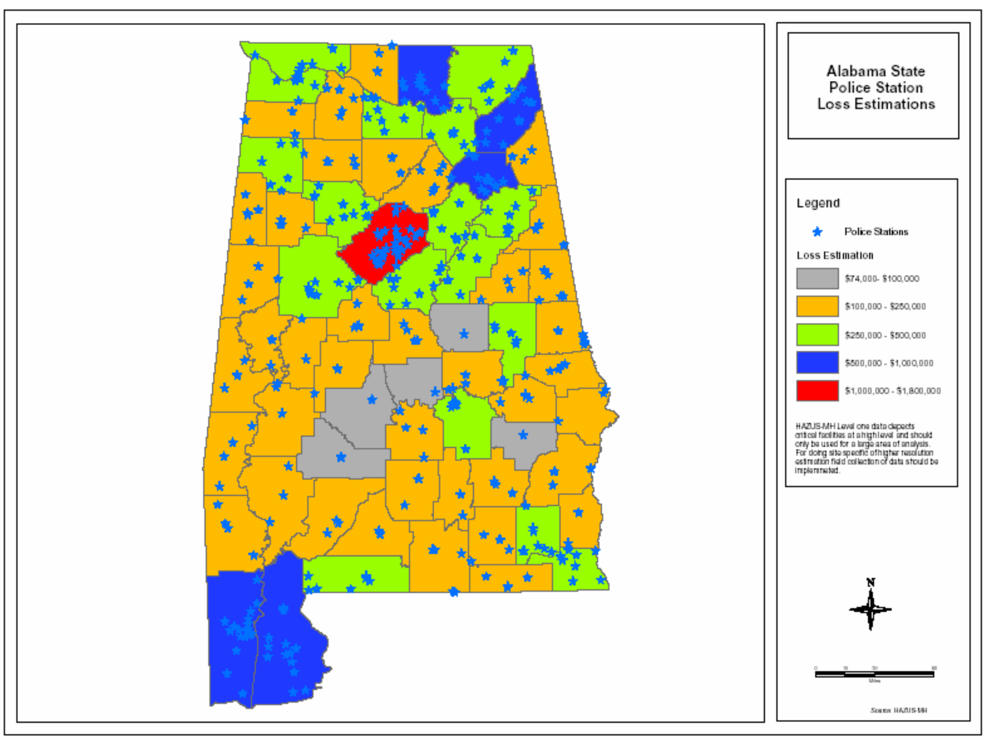
County	Police	Schools	Fire	EOCs	Total	% of Total
Blount	$223,776	$940,108	$175,824	$0	$1,339,708	1.12%
Tallapoosa	$261,072	$842,250	$111,888	$26,640	$1,241,850	1.04%
Escambia	$261,072	$735,957	$239,760	$0	$1,236,789	1.03%
Chilton	$186,480	$779,261	$223,776	$26,640	$1,216,157	1.02%
Coffee	$186,480	$951,131	$47,952	$26,640	$1,212,203	1.01%
Lawrence	$223,776	$785,448	$159,840	$0	$1,169,064	0.98%
Russell	$111,888	$978,351	$47,952	$26,640	$1,164,831	0.97%
Autauga	$74,592	$972,165	$111,888	$0	$1,158,645	0.97%
Marion	$298,368	$589,508	$207,792	$53,280	$1,148,948	0.96%
Clarke	$149,184	$639,899	$127,872	$26,640	$943,595	0.79%
Marengo	$186,480	$603,005	$95,904	$26,640	$912,029	0.76%
Barbour	$223,776	$572,636	$111,888	$0	$908,300	0.76%
Franklin	$186,480	$624,939	$95,904	$0	$907,323	0.76%
Monroe	$111,888	$607,280	$175,824	$0	$894,992	0.75%
Chambers	$223,776	$572,636	$79,920	$0	$876,332	0.73%
Covington	$186,480	$519,433	$127,872	$0	$833,785	0.70%
Winston	$223,776	$472,641	$127,872	$0	$824,289	0.69%
Cherokee	$186,480	$445,646	$143,856	$26,640	$802,622	0.67%
Macon	$186,480	$466,455	$143,856	$0	$796,791	0.67%
Bibb	$223,776	$433,048	$79,920	$0	$736,744	0.62%
Pike	$149,184	$502,336	$79,920	$0	$731,440	0.61%
Randolph	$186,480	$436,085	$63,936	$26,640	$713,141	0.60%
Choctaw	$186,480	$339,240	$143,856	$26,640	$696,216	0.58%
Butler	$111,888	$511,334	$47,952	$0	$671,174	0.56%
Washington	$149,184	$408,527	$111,888	$0	$669,599	0.56%
Pickens	$186,480	$302,571	$159,840	$0	$648,891	0.54%
Lamar	$186,480	$315,281	$95,904	$0	$597,665	0.50%
Geneva	$149,184	$351,837	$79,920	$0	$580,941	0.49%
Clay	$149,184	$326,979	$95,904	$0	$572,067	0.48%
Fayette	$149,184	$313,482	$79,920	$26,640	$569,226	0.48%
Lowndes	$149,184	$335,078	$31,968	$26,640	$542,870	0.45%
Perry	$149,184	$297,847	$63,936	$26,640	$537,607	0.45%
Sumter	$149,184	$304,371	$79,920	$0	$533,475	0.45%
Cleburne	$149,184	$287,611	$63,936	$26,640	$527,371	0.44%
Henry	$111,888	$335,978	$63,936	$0	$511,802	0.43%
Hale	$111,888	$309,095	$47,952	$26,640	$495,575	0.41%
Wilcox	$74,592	$346,663	$63,936	$0	$485,191	0.41%
Crenshaw	$149,184	$262,078	$63,936	$0	$475,198	0.40%
Greene	$111,888	$215,399	$95,904	$0	$423,191	0.35%
Conecuh	$111,888	$165,683	$95,904	$0	$373,475	0.31%
Bullock	$74,592	$236,096	$15,984	$0	$326,672	0.27%
Coosa	$74,592	$43,417	$31,968	$0	$149,977	0.13%
Statewide	**$17,529,120**	**$89,681,767**	**$11,652,336**	**$719,280**	**$119,582,503**	**100.00%**

Figure 5.5-12
Flood Loss Estimate for Public Schools in Alabama



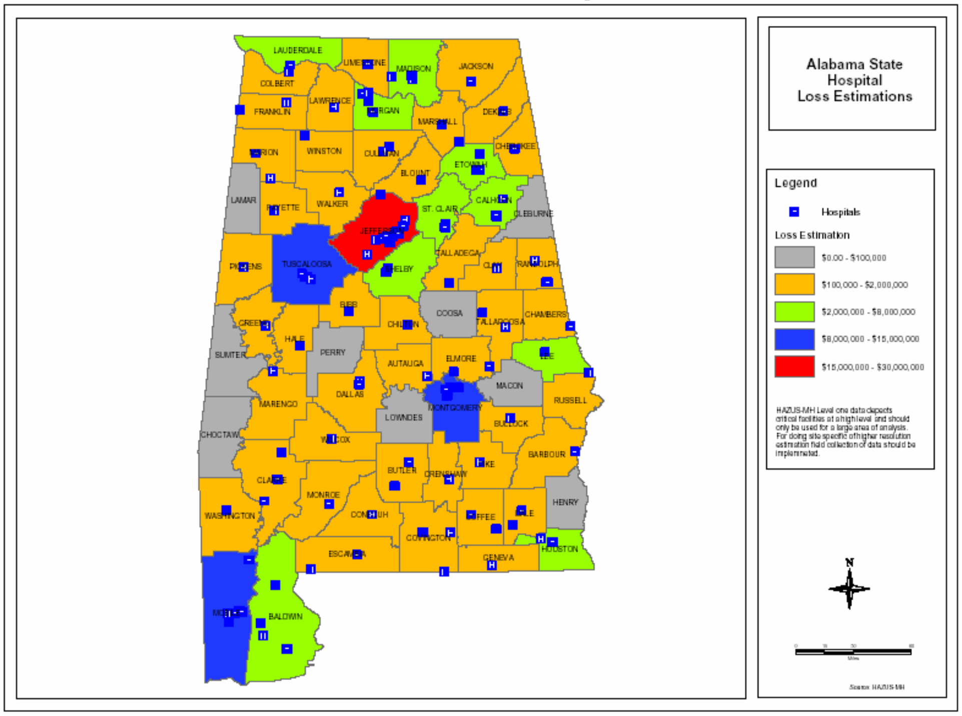
Source: FEMA/HAZUS

Figure 5.5-13
Flood Loss Estimate for Police Stations in Alabama



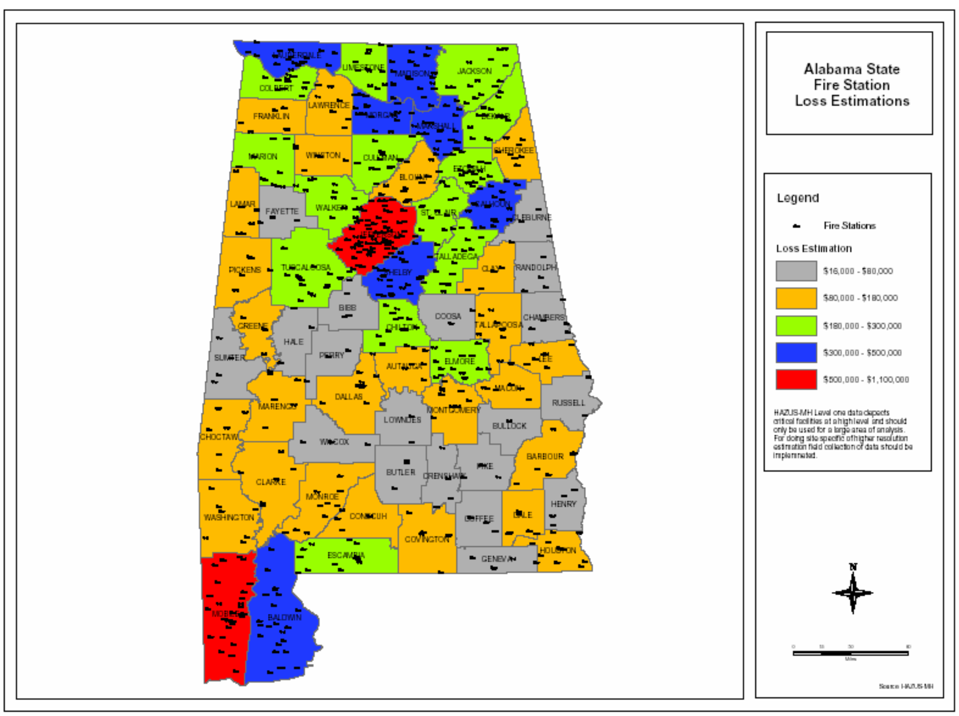
Source: FEMA/HAZUS

Figure 5.5-14
Flood Loss Estimate for Hospitals in Alabama



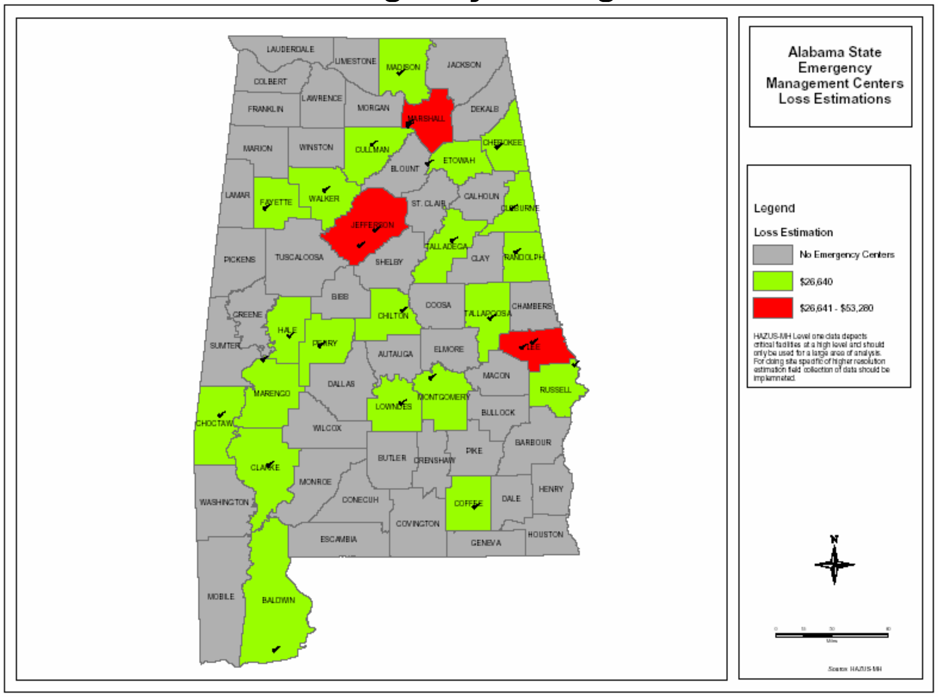
Source: FEMA/HAZUS

Figure 5.5-15
Flood Loss Estimate for Fire Stations in Alabama



Source: FEMA/HAZUS

Figure 5.5-16
Flood Loss Estimate for Emergency Management Centers in Alabama



Source: FEMA/HAZUS

Methodology 5 – NOAA Storm Surge Inundation Limits

Because storm surge only affects coastal areas, this methodology focuses solely on Mobile and Baldwin Counties. A considerable number of studies of inundation limits and potential surge elevations have been conducted since Hurricanes Katrina and Ivan. The following analysis utilized surged inundation limits collected from NOAA. The inundation limits from different categories of hurricanes are shown in **Section 5.2, Figures 5.2-1 and 5.2-2**.

To supplement other data about hurricane storm surge risk, AEMA used critical facility data from HAZUS combined with the surge inundation limits obtained from NOAA to indicate the numbers of essential facilities (as defined by HAZUS) that are located within the surge inundation limits of each category hurricane. This is not intended as an exact indication of risk, but shows the overall exposures for five facility types. HAZUS output includes the names of the facilities as well, but these are not included in this section. These facilities may be included in more detailed assessments in the future, although that will be determined after additional consideration by AEMA and the local communities.

Table 5.5-13 shows the numbers of essential facilities by type in each of the five surge zones. Note that facilities in surge Zone 1 are at highest risk because they will also be inundated by surges that reach Zones 2 through 5.

Table 5.5-13
Essential Facilities within NOAA Surge Inundation Limits for Different Levels of Hurricanes in Mobile and Baldwin Counties

Essential Facility Type	Storm Surge Category				
	1	2	3	4	5
Emergency Operations Centers	1	1	1	1	0
Medical Care Facilities	0	0	2	2	0
Police Stations	3	4	8	11	0
Fire Stations	6	7	10	12	0
Schools	5	7	19	27	0

Source: NOAA and FEMA/HAZUS

5.5.2.3 State-owned Facilities in Flood Hazard Areas

At the time the initial version of this plan was developed, no reliable list of State-owned facilities existed outside FEMA's HAZUS software, which does not discriminate between State- and locally-owned public facilities. As part of the planning process, State agencies were asked about their flood risk, but the answers to this query cannot be considered an accurate determination of flood risk. A central recommendation of the initial plan is that the State perform an inventory of its facilities, and then gather basic information about them to support more detailed and accurate risk assessments.

Because of the events of 2004 and 2005, priorities were necessarily shifted and this inventory was not developed. However, part of the State's longer-term effort in this update is to initiate the process of inventorying and prioritizing State facilities for more detailed risk assessments, for flood, wind and earthquake hazards. AEMA expects this process to take about one year (estimated completion in summer 2008). The inventory and prioritization process will use (1) the State's risk management database, which includes a complete inventory of Alabama facilities and (2) the State insurance claims database, which will provide some insight into the loss history. The process of developing this prioritized list has not yet been fully detailed, but will include a combination of use, value, criticality, maximum occupancy, structure type (where applicable) and loss history. After the prioritized list is developed, the State intends to perform risk assessments using standard methodologies that incorporate a range of facility-specific data, loss histories, and engineering information to calculate potential future losses from natural hazards. After this effort is complete, the State will update both this Plan and the State GIS to include the inventory process and risk assessment results from the detailed studies.

5.5.2.4 Potential Dollar Losses to State Facilities in Flood Hazard Areas

Flood risk assessment Method 4 (above), and **Tables 5.5-12** provide estimated dollar losses to essential facilities due to floods. The inventory of facilities and the loss calculation were performed using the FEMA HAZUS tool. Facilities included police and fire stations, emergency operations centers, schools, and hospitals. As noted elsewhere, it is unlikely that HAZUS provides a comprehensive inventory of State-owned facilities. Numerous roads and other public infrastructure may be at risk from floods and other hazards, and are not included in this plan because of a lack of reliable data. It should also be noted that the facilities in the HAZUS output shown in **Table 5.5-12** is not necessarily all State-owned and/or operated facilities. In some cases the assets may be owned or operated by regional, county or local authorities. This part of the risk assessment is intended to provide supporting data for the overall result.

As noted elsewhere in this plan, at the time these risk assessments were performed there was no comprehensive inventory of State-owned and/or operated facilities that included sufficient data to allow detailed risk assessment. After completion of this standard plan update, the State intends to develop a prioritized inventory of critical State-owned critical facilities. The State will also perform detailed risk assessments on a select group of these facilities. This plan will include a new section describing the results of this effort.

5.5.3 Wind Risk

As discussed throughout this document, the SHMT decided early in the plan update process that it would separate the wind and flood elements of hurricanes into separate hazards. The team then combined tornados and the wind elements of hurricanes into a single hazard.

5.5.3.1 Summary of Local Risk Assessments

Potential loss estimates for wind events from local hazard mitigation plans can be found in **Section 5.5.1**.

5.5.3.2 Statewide Risk Assessment for Wind

Tornado Methodology - Analysis of Historic Data Obtained from NOAA

As described in **Section 5.2**, tornados are prevalent over the entire State of Alabama. NOAA maintains a database of tornados that extends back about 50 years. The database includes tornado strength, dollar damages and numbers of injuries and deaths. The NOAA database subdivides the information by county, so it is possible to report the numbers of tornados and the injuries and casualties at that level.

The NOAA data provided numbers of tornados by Fujita Class (see **Appendix H**), damages in dollars, and injuries and deaths. The data are provided by year of occurrence. To determine statewide tornado risk, the NOAA data was first sorted by County and year. The figures for injuries and casualties were reported as raw numbers, so the data were converted to dollar figures using the values shown in **Table 5.5-14** below.

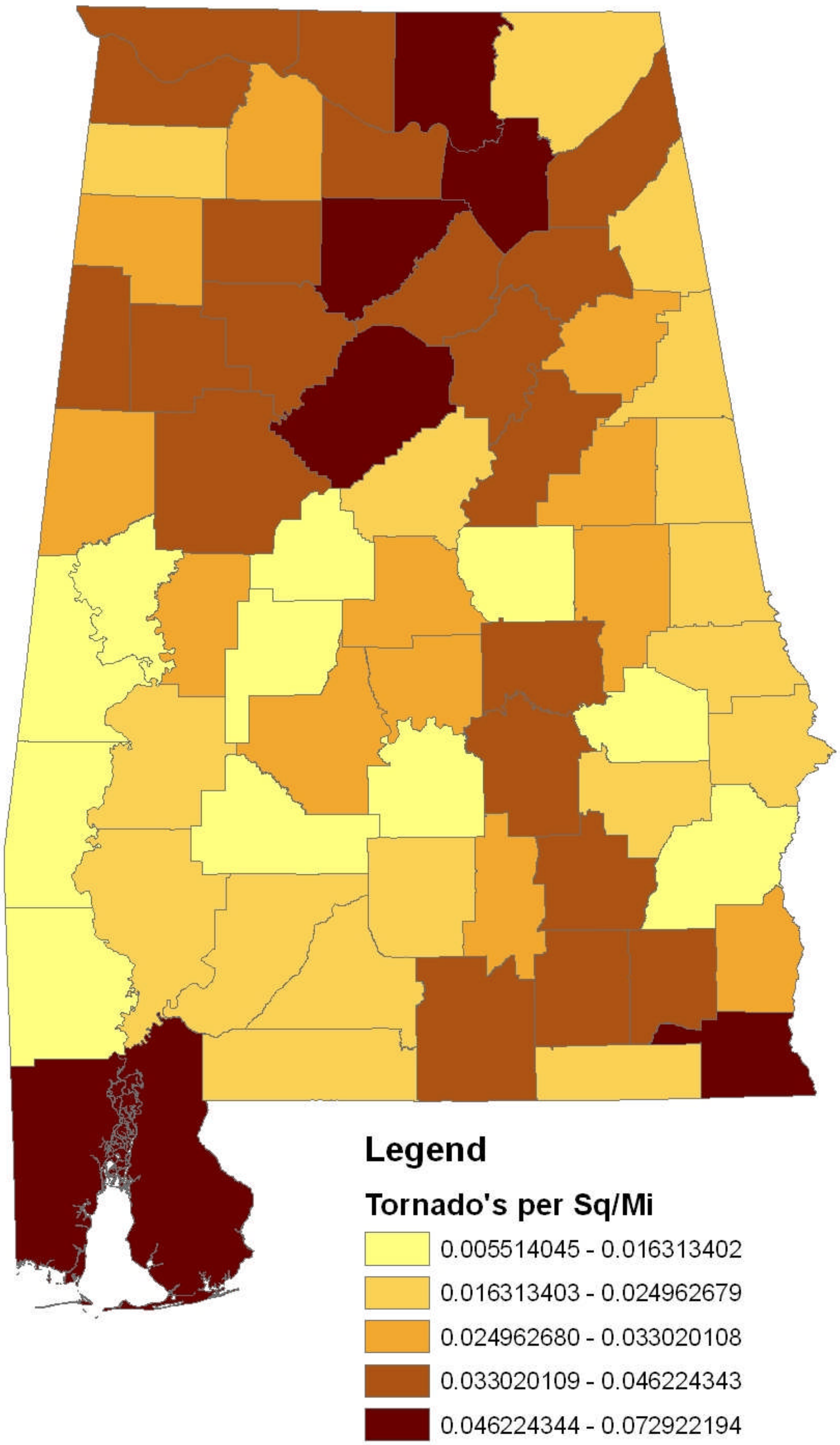
Table 5.5-14
Values used for Monetary Conversion of Tornado Injuries and Deaths

Damage Category	Value for Monetary Conversion
Injury (blended major and minor)	$12,500
Death	$2,200,000

The figures used for valuation of deaths and injuries are approximations based on FEMA guidance used in benefit-cost analysis of hazard mitigation measures. Major and minor injuries are combined in the NOAA data, so it was necessary to use a blended number in the valuation.

The county and statewide damage, injury and casualty data were then projected to a 30-year horizon and discounted using a 7% discount rate, in accordance with OMB guidance (Circular No. A-94). The resulting data were subsequently disaggregated to separate damages related to injuries and deaths from other damages. This was done because deaths cause a strong bias in the outcome because of their extremely high value.

Figure 5.5-17
Tornados per Square Mile, 1950-2006



Source: National Climatic Data Center

Table 5.5-15
Summary of Tornado Risk by County

County Name	# Of Tornados	Tornados (Damage Only)			Tornados (Damage + Casualties)		
		Total	Annual Average	30-Year NPV	Total	Annual Average	30-Year NPV
Madison County	48	$523,894,000	$9,355,250	$116,098,653	$583,819,000	$10,425,339	$129,378,461
Jefferson County	70	$275,985,000	$4,928,304	$61,160,247	$475,297,500	$8,487,455	$105,329,321
Tuscaloosa County	52	$75,952,000	$1,356,286	$16,831,506	$112,127,000	$2,002,268	$24,848,144
Walker County	33	$40,058,000	$715,321	$8,877,139	$80,108,000	$1,430,500	$17,752,505
Cullman County	55	$70,260,000	$1,254,643	$15,570,118	$78,610,000	$1,403,750	$17,420,538
Shelby County	20	$32,618,000	$582,464	$7,228,382	$58,605,500	$1,046,527	$12,987,397
Dale County	26	$40,655,000	$725,982	$9,009,438	$51,417,500	$918,170	$11,394,485
St. Clair County	23	$35,034,000	$625,607	$7,763,785	$44,921,500	$802,170	$9,954,925
Talladega County	29	$30,490,000	$544,464	$6,756,802	$42,327,500	$755,848	$9,380,076
Clay County	20	$26,589,000	$474,804	$5,892,312	$42,276,500	$754,938	$9,368,774
Morgan County	23	$13,784,000	$246,143	$3,054,633	$39,071,500	$697,705	$8,658,523
Bibb County	9	$25,830,000	$461,250	$5,724,113	$37,417,500	$668,170	$8,291,985
Pickens County	28	$32,078,000	$572,821	$7,108,714	$37,128,000	$663,000	$8,227,830
Hale County	21	$26,515,000	$473,482	$5,875,913	$34,165,000	$610,089	$7,571,208
Russell County	14	$27,929,000	$498,732	$6,189,266	$33,004,000	$589,357	$7,313,922
Fayette County	28	$27,459,000	$490,339	$6,085,111	$32,296,500	$576,723	$7,157,135
Montgomery County	34	$14,449,000	$258,018	$3,202,002	$30,986,500	$553,330	$6,866,830
Perry County	11	$28,534,000	$509,536	$6,323,338	$28,596,500	$510,652	$6,337,189
Dallas County	28	$16,742,000	$298,964	$3,710,147	$28,554,500	$509,902	$6,327,881
Lee County	12	$8,152,000	$145,571	$1,806,541	$24,014,500	$428,830	$5,321,785
Limestone County	25	$17,645,000	$315,089	$3,910,258	$22,957,500	$409,955	$5,087,546
DeKalb County	28	$16,051,000	$286,625	$3,557,016	$21,313,500	$380,598	$4,723,224
Marshall County	33	$19,988,000	$356,929	$4,429,484	$20,913,000	$373,446	$4,634,470
Etowah County	21	$15,957,000	$284,946	$3,536,185	$16,357,000	$292,089	$3,624,828
Henry County	16	$13,735,000	$245,268	$3,043,774	$16,347,500	$291,920	$3,622,723
Coffee County	29	$14,867,000	$265,482	$3,294,633	$15,342,000	$273,964	$3,399,897

Table 5.5-15
Summary of Tornado Risk by County

County Name	# Of Tornados	Tornados (Damage Only) Total	Tornados (Damage Only) Annual Average	Tornados (Damage Only) 30-Year NPV	Tornados (Damage + Casualties) Total	Tornados (Damage + Casualties) Annual Average	Tornados (Damage + Casualties) 30-Year NPV
Blount County	27	$7,616,000	$136,000	$1,687,760	$15,066,000	$269,036	$3,338,733
Calhoun County	20	$4,892,000	$87,357	$1,084,102	$14,854,500	$265,259	$3,291,863
Colbert County	25	$6,703,000	$119,696	$1,485,433	$11,840,500	$211,438	$2,623,939
Covington County	37	$7,120,000	$127,143	$1,577,843	$11,720,000	$209,286	$2,597,236
Baldwin County	87	$9,398,000	$167,821	$2,082,664	$10,460,500	$186,795	$2,318,122
Elmore County	27	$10,232,000	$182,714	$2,267,484	$10,444,500	$186,509	$2,314,576
Winston County	22	$4,888,000	$87,286	$1,083,216	$9,863,000	$176,125	$2,185,711
Cherokee County	12	$2,914,000	$52,036	$645,763	$9,826,500	$175,473	$2,177,623
Jackson County	21	$9,251,000	$165,196	$2,050,088	$9,563,500	$170,777	$2,119,340
Lamar County	23	$4,587,000	$81,911	$1,016,512	$9,037,000	$161,375	$2,002,664
Randolph County	14	$6,068,000	$108,357	$1,344,712	$8,443,000	$150,768	$1,871,029
Houston County	31	$7,923,000	$141,482	$1,755,793	$8,210,500	$146,616	$1,819,505
Chambers County	12	$3,470,000	$61,964	$768,977	$8,045,000	$143,661	$1,782,829
Mobile County	71	$4,692,000	$83,786	$1,039,781	$7,454,500	$133,116	$1,651,970
Chilton County	19	$4,433,000	$79,161	$982,384	$7,133,000	$127,375	$1,580,724
Lauderdale County	25	$2,283,000	$40,768	$505,929	$6,858,000	$122,464	$1,519,782
Geneva County	13	$3,383,000	$60,411	$749,697	$5,758,000	$102,821	$1,276,014
Butler County	18	$991,000	$17,696	$219,613	$5,566,000	$99,393	$1,233,465
Choctaw County	9	$435,000	$7,768	$96,399	$4,897,500	$87,455	$1,085,321
Pike County	27	$4,617,000	$82,446	$1,023,160	$4,692,000	$83,786	$1,039,781
Autauga County	17	$4,552,000	$81,286	$1,008,756	$4,689,500	$83,741	$1,039,227
Monroe County	18	$4,050,000	$72,321	$897,509	$4,575,000	$81,696	$1,013,853
Conecuh County	21	$1,873,000	$33,446	$415,070	$4,123,000	$73,625	$913,686
Crenshaw County	17	$3,555,000	$63,482	$787,813	$3,930,000	$70,179	$870,916
Sumter County	10	$3,597,000	$64,232	$797,121	$3,622,000	$64,679	$802,661
Coosa County	9	$3,571,000	$63,768	$791,359	$3,596,000	$64,214	$796,899
Marion County	21	$2,848,000	$50,857	$631,137	$3,373,000	$60,232	$747,481

Table 5.5-15
Summary of Tornado Risk by County

County Name	# Of Tornados	Tornados (Damage Only)			Tornados (Damage + Casualties)		
		Total	Annual Average	30-Year NPV	Total	Annual Average	30-Year NPV
Tallapoosa County	21	$3,248,000	$58,000	$719,780	$3,335,500	$59,563	$739,171
Barbour County	14	$3,139,000	$56,054	$695,625	$3,239,000	$57,839	$717,786
Franklin County	14	$663,000	$11,839	$146,926	$2,963,000	$52,911	$656,622
Clarke County	25	$2,359,000	$42,125	$522,771	$2,596,500	$46,366	$575,403
Marengo County	17	$1,907,000	$34,054	$422,605	$1,969,500	$35,170	$436,455
Lawrence County	19	$1,600,000	$28,571	$354,571	$1,662,500	$29,688	$368,422
Lowndes County	11	$1,330,000	$23,750	$294,738	$1,642,500	$29,330	$363,990
Cleburne County	14	$1,173,000	$20,946	$259,945	$1,285,500	$22,955	$284,876
Washington County	17	$1,169,000	$20,875	$259,059	$1,169,000	$20,875	$259,059
Greene County	7	$1,103,000	$19,696	$244,433	$1,115,500	$19,920	$247,203
Escambia County	20	$981,000	$17,518	$217,397	$1,043,500	$18,634	$231,247
Macon County	10	$891,000	$15,911	$197,452	$1,016,000	$18,143	$225,153
Bullock County	11	$756,000	$13,500	$167,535	$793,500	$14,170	$175,845
Wilcox County	5	$313,000	$5,589	$69,363	$338,000	$6,036	$74,903
Statewide	**1594**	**$1,621,824,000**	**$28,961,143**	**$359,407,783**	**$2,239,786,500**	**$39,996,188**	**$496,352,687**

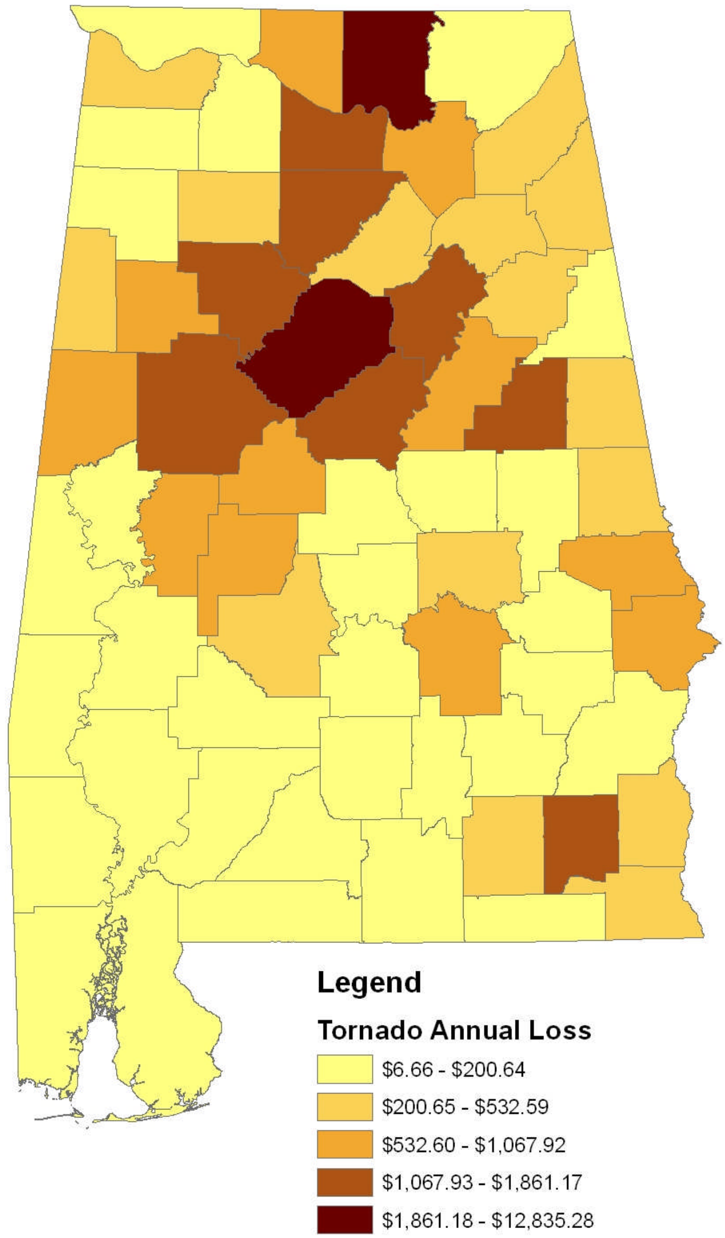
Source: National Climatic Data Center
Note: The term NPV in the table stands for Net Present Value, which is the total expected future losses (risk) based on an annualized damage figure, a 30-year time horizon, and a 7% discount rate, as required by OMB guidance.

It is clear from the distribution of tornado occurrences statewide shown in the NOAA database that the coastal counties have much higher tornado probability than do others. Specifically, Baldwin and Mobile Counties lead the State in tornado occurrences. This is presumably because of the influence of hurricanes in producing tornados and waterspouts. It should also be noted that tornado probability is not perfectly analogous to risk, because risk is created only when assets or operations will be negatively impacted by the hazard. In the case of the two counties noted above, the relatively high populations and development do produce considerable risk. **Table 5.5-15** above includes separate calculations of physical damages and casualties based on past tornado occurrences. Note that including casualties adds significantly to the risk, as is the case with all hazards that can result in deaths or injuries. Although the potential dollar losses appear very large, it is important to consider that tornados are almost impossible to predict in a particular place more than a very short period in advance and there is a relatively small range of cost-effective mitigation options available to protect against more severe events.

Table 5.5-16
Alabama Tornado Past Damages and Future Risk by Category

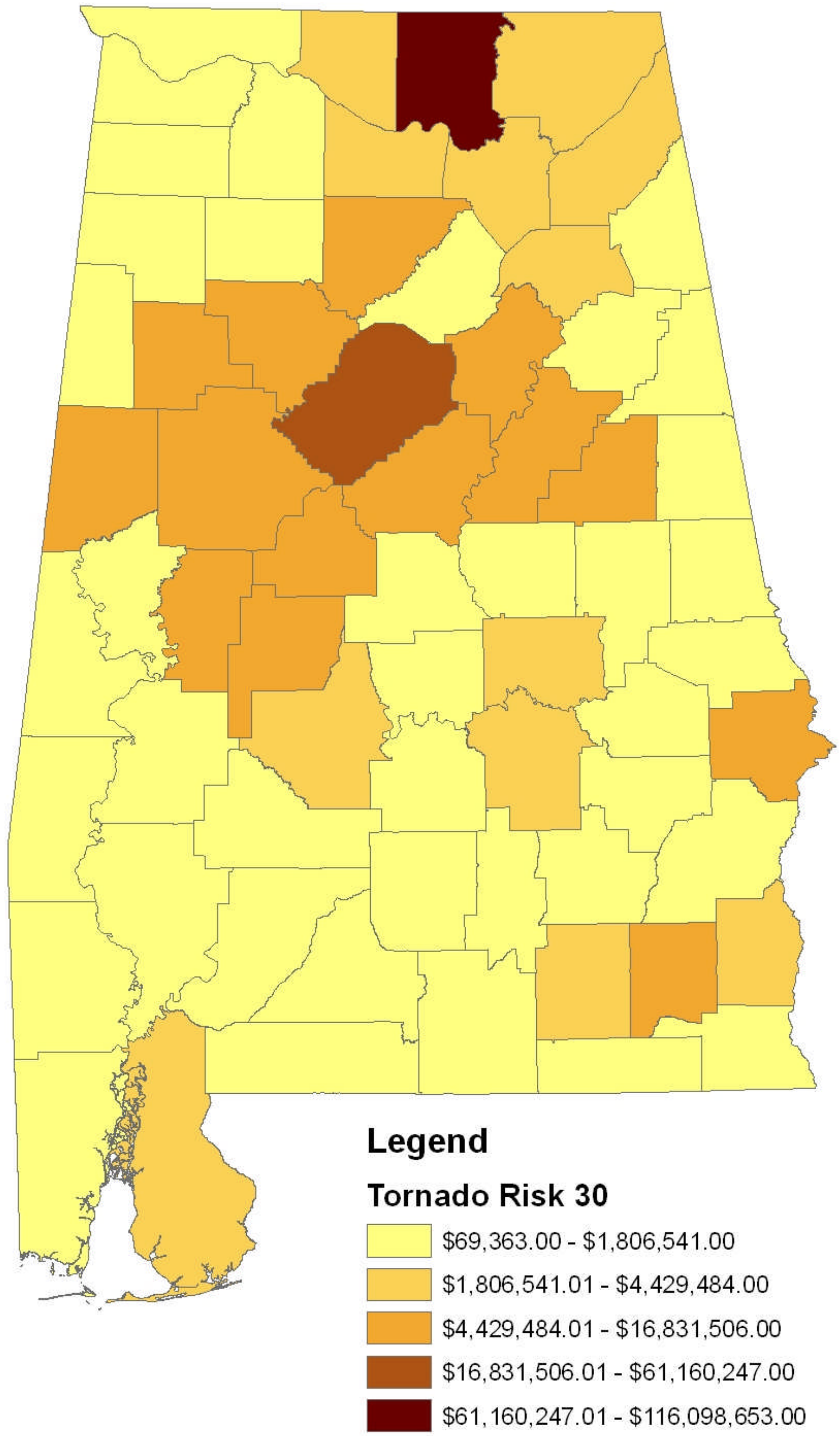
Damage Category	Past Damage	Annual Damage	Future Risk
Building/Structure/Infrastructure	$1,621,824,000	$28,961,143	$359,407,783
Injuries and Casualties	$617,962,500	$11,035,045	$13,694,490
All categories	$2,239,786,500	$39,996,188	$496,352,687

Figure 5.5-18
Average Annual Tornado Loss in Thousands of Dollars
1950-2006 (Updated)



Source: National Climatic Data Center

Figure 5.5-19
Total 30-year Tornado Risk Projections Based on Historical Losses in Thousands of Dollars, 1950-2006 (Updated)



Source: National Climatic Data Center

Strengths, Biases and Limitations of the Methodology

Alabama has a well-established history of tornados, and the NOAA database is large enough that it is reasonable to use past occurrences as a general indicator of future risk, at least on a statewide basis. Clearly, as with all risks, the presence of vulnerable assets (including people) in particular areas increases risk because of the potential for damage, injury and death. Because tornados occur relatively quickly (as opposed to floods and hurricanes, both of which are usually preceded by long-lead time warnings and predictions about their severity) several additional factors must be considered in assessing risk, including: the presence and effectiveness of warning systems, public knowledge about what to do if a tornado does occur, the willingness of the population to take appropriate action, and the availability of adequate shelter (both in terms of its proximity to potential users, structural characteristics, and potential occupancy level).

Using past occurrence data to estimate future risk can be particularly problematic for tornados, except in the most general sense. It is important to understand that tornados are a widespread phenomenon in most central U.S. States. Much of the record of tornado events is based on *observations* of tornados forming or touching the ground, or on after-the-fact empirical observations of the damage they caused. Because of this, it is appropriate to assume that the probabilities are somewhat higher than what is suggested by the data – in many cases tornados occur in unpopulated places where they are neither observed nor cause any damage or injuries.

Tornado probabilities are primarily influenced by weather and topography, and can be expected to remain relatively static over a long period of time, although actual year-to-year occurrences may vary. The NOAA database indicates that Alabama experienced 1,594 tornados from 1953 to 2007, an average of 28 per year statewide. Of these, the majority were Fujita class F-0 to F-2. As noted previously, the database shows a prevalence of tornados in the coastal areas. This is probably the result of hurricane-generated tornados and waterspouts. Given that tornado incidence in these counties is significantly higher than much of the rest of the State, it is not likely that the higher numbers are a reporting artifact, so it can be reasonably assumed that these figures will remain constant (particularly relative to each other) over the long term.

As with the other hazards, it is important to note that tornado probability and tornado risk are not the same, although probability is a key determinant of risk. Although tornados clearly have great potential to damage physical assets, the most significant damage they cause is in the form of injuries and casualties. Because of this, all other factors being equal, the *risk* from tornados is highly correlated with population density, the presence and efficacy of warning systems, and the availability and proximity of appropriate shelter.

Hurricane Methodology – HAZUS Calculation of Losses

Hurricanes mainly affect the coastal areas of Alabama, although their effects may be felt a considerable distance inland as well, in the form of rain and wind. Typically, hurricane wind speeds decay markedly as storms move away from the open waters of the Gulf of Mexico.

As noted in previous sections, hurricane damages usually result from a combination of wind and flooding. This can result in difficulties disaggregating data about flood damages because flood and hurricane damage databases often overlap. There is a National Oceanographic and Atmospheric Administration (NOAA) database of hurricanes, but a review of the data seems to indicate that it may be somewhat unreliable in terms of the reported dollar damages. It is clear that hurricanes present a serious risk because of their potential severity and large scale.

FEMA's HAZUS-MH software was used for the analysis in this section. The figures in **Table 5.5-17** are annual losses in the *Direct, Business* and *Total Loss* columns. The *Future Loss* column is the estimated future losses by County over a 30-year horizon, consistent with the other analyses in this section.

Table 5.5-17
HAZUS Calculation of Dollar Losses
(Note all figures are in thousands)

County	Annual Direct Loss	Annual Business Loss	Annul Total Loss	Future Loss – 30 year horizon
Mobile	$153,304	$30,080	$183,384	$2,275,792
Baldwin	$82,496	$15,217	$97,713	$1,212,623
Jefferson	$8,704	$1,393	$10,097	$125,299
Montgomery	$6,757	$1,266	$8,022	$99,557
Houston	$6,033	$1,264	$7,297	$90,554
Blount	$5,255	$1,339	$6,594	$81,835
Escambia	$4,357	$881	$5,238	$65,007
Madison	$3,224	$477	$3,701	$45,927
Coffee	$2,692	$526	$3,218	$39,941
Covington	$2,424	$534	$2,958	$36,708
Shelby	$2,328	$300	$2,628	$32,609
Dale	$2,211	$412	$2,623	$32,556
Tuscaloosa	$2,216	$367	$2,582	$32,046
Geneva	$2,106	$429	$2,534	$31,451
Lee	$1,650	$279	$1,929	$23,935
Elmore	$1,429	$217	$1,646	$20,424
Monroe	$1,262	$251	$1,513	$18,780
Calhoun	$1,136	$198	$1,334	$16,558
Clarke	$1,090	$217	$1,308	$16,228
Morgan	$1,050	$161	$1,210	$15,018
Autauga	$992	$162	$1,154	$14,317
Washington	$921	$182	$1,103	$13,684
Etowah	$927	$166	$1,093	$13,568
Pike	$903	$187	$1,090	$13,522
Talladega	$863	$144	$1,006	$12,489
Marshall	$831	$141	$972	$12,059
Dallas	$792	$173	$965	$11,982
Lauderdale	$748	$136	$883	$10,964
Henry	$703	$122	$826	$10,246
Russell	$647	$116	$763	$9,467
Limestone	$637	$100	$736	$9,138
Cullman	$626	$106	$732	$9,085
Conecuh	$583	$122	$705	$8,751
Butler	$579	$123	$702	$8,708
Barbour	$566	$108	$673	$8,358
Tallapoosa	$573	$98	$671	$8,328
Chilton	$575	$95	$670	$8,314
Saint Clair	$584	$85	$669	$8,298
Colbert	$554	$102	$656	$8,142
Marengo	$521	$106	$627	$7,780
DeKalb	$495	$87	$582	$7,218
Walker	$474	$75	$549	$6,811
Crenshaw	$450	$87	$537	$6,661

Table 5.5-17
HAZUS Calculation of Dollar Losses
(Note all figures are in thousands)

County	Annual Direct Loss	Annual Business Loss	Annul Total Loss	Future Loss – 30 year horizon
Jackson	$395	$64	$460	$5,703
Chambers	$386	$69	$455	$5,648
Choctaw	$363	$72	$435	$5,400
Macon	$329	$65	$394	$4,890
Hale	$305	$56	$360	$4,470
Lawrence	$266	$44	$310	$3,850
Lowndes	$262	$47	$309	$3,833
Wilcox	$242	$53	$295	$3,667
Sumter	$220	$47	$267	$3,314
Cherokee	$221	$38	$259	$3,219
Perry	$215	$39	$254	$3,153
Bibb	$202	$32	$234	$2,902
Pickens	$193	$38	$231	$2,870
Franklin	$192	$37	$229	$2,847
Randolph	$194	$34	$228	$2,827
Marion	$190	$37	$228	$2,824
Bullock	$187	$37	$223	$2,772
Winston	$160	$26	$187	$2,316
Fayette	$148	$27	$176	$2,182
Coosa	$146	$22	$168	$2,088
Greene	$131	$27	$157	$1,952
Clay	$123	$22	$144	$1,791
Lamar	$116	$23	$139	$1,719
Cleburne	$96	$16	$112	$1,394
Statewide	**$312,546**	**$59,603**	**$372,149**	**$4,618,367**

The statewide risk pattern for hurricane wind is similar to the estimated risk for flooding. As noted earlier, this result is related to the populations and locations of the highest-risk areas in the State. **Table 5.5-18** shows summary data for the hurricane wind risk.

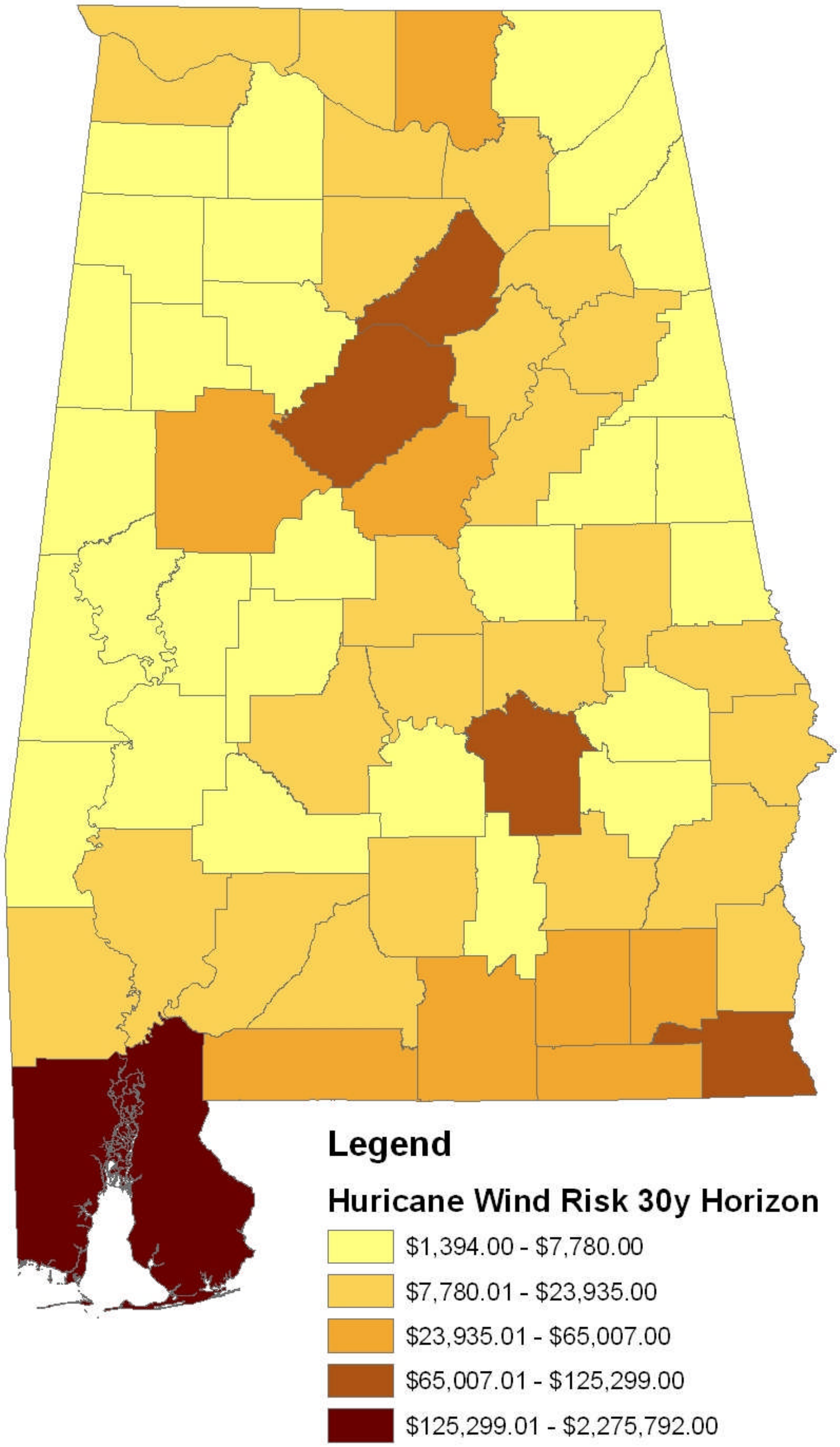
Table 5.5-18
HAZUS Hurricane Analysis: Selected Parameters

Parameter	Annual Losses	Future Risk
Highest risk (Baldwin)	$183,384,000	$2,275,792,000
Average risk	$5,554,000	$68,931,000
Median risk (Conecuh)	$705,000	$8,751,000

Strengths, Biases and Limitations of the Methodology

These results are based on a default-data risk assessment from FEMA's HAZUS software. The patterns in the result are as predicted, and the most current version of HAZUS was used in the assessment, so the results are presumed to be reasonably reliable. Like any software, HAZUS is only as good as the information in its database.

Figure 5.5-20
Total 30-year Hurricane Wind Risk Projections in Thousands of Dollars (Updated)



Source: FEMA / HAZUS

5.5.3.3 Potential Dollar Losses to State Facilities in High Wind Hazard Areas

As noted elsewhere in this plan, at the time these risk assessments were performed there was no comprehensive inventory of State-owned and/or operated facilities that included sufficient data for a detailed risk assessment. Without facility-, population- and operation-specific information, it is not presently possible to estimate losses to State facilities with sufficient accuracy to make the estimates that would be useful in prioritizing mitigation activities. As noted in the previous sub-section, the State should initiate the data-gathering process with an inventory of its most important facilities; prioritize these by potential risk, then gather the data that would be required to perform a formal risk assessment. **Section 5.5.4** of this plan provides a brief additional assessment of this issue, and specific actions that the State is contemplating or already undertaking to address data insufficiencies.

Upon completion of this inventory, the State will be able to combine this with high wind hazard maps for both hurricanes and tornados to delineate which facilities are in the high wind hazard areas. The State will also conduct detailed risk assessment on a subset of these facilities based on the prioritization process. The result of this work will be incorporated into this risk assessment.

There is clearly more hurricane risk in the counties that border the Gulf of Mexico, especially in terms of wind and surge effects, and this can provide a clear way to prioritize where additional data-gathering efforts will occur. As a starting point, the State should use the prioritized inventory noted above as the basis for developing an inventory of data required for detailed risk assessment. The need for the data, as well as its utility, will be influenced by other factors as well. However, it is possible to develop a basic set of common data points applicable to hurricane risk without extremely complex analysis.

Although there is clearly some tornado risk differential across the State due to the influences of climate and topography, the primarily determinants of risk are population, availability of shelter, warning, and asset-specific characteristics (for example, building structural system, etc.). As a starting point, the State should use the prioritized inventory noted above as the basis for developing an inventory of data required for detailed risk assessment. The need for the data, as well as its utility, will be influenced by other factors as well, but it is possible to develop a basic set of common data points applicable to tornado risk without the requirement for very complex analysis.

5.5.4 Seismic Risk

Calculating seismic risk requires detailed information about the potential for earthquakes, soil characteristics and the likely behavior of buildings and infrastructure when they are subjected to shaking. As discussed elsewhere in this document, the State of Alabama was awaiting improved shake and soils data at the time the 2007 Plan update was being completed. When this data is available, the State will undertake more detailed risk assessments of a select set of critical facilities. As an intermediate step in this process, the State used FEMA's HAZUS software to determine risk for a study area that included nine of the most populous Counties in the State. The State is working towards using this software to determine risk for remaining counties; however, results were not yet available at the time of this writing.

5.5.4.1 Summary of Local Risk Assessments

A review of local hazard mitigation plans revealed that no plans contained potential loss estimates for earthquakes due to a lack of data and historical damages.

5.5.4.2 Statewide Risk Assessment for Earthquakes

Earthquake Methodology – HAZUS Calculation of Losses

FEMA's HAZUS software was used to estimate seismic risk for the nine most populous counties in Alabama. The methodology uses HAZUS default data about seismic hazards across the State in conjunction with statewide essential facility information, and the software's standard algorithms. The calculation algorithms estimate annual seismic risk (expected losses) using information about "shake" probabilities and soil characteristics, among other parameters. To convert the estimated annual losses, the methodology uses a present value coefficient of 12.41 multiplied by the annual losses. The coefficient combines the required 7 percent discount rate with a standard 30-year time horizon to calculate future losses probable losses over that period. **Table 5.5-19** shows the HAZUS direct physical losses to structures, contents and inventory in the study area.

Table 5.5-19
Estimated Seismic Risk to Nine Most Populous Alabama Counties; Direct Physical Losses to Structures, Contents and Inventory

County	Structural	Contents	Inventory	Total
Baldwin	$13,000	$0	$0	$13,000
Houston	$9,000	$0	$0	$9,000
Jefferson	$613,000	$506,000	$14,000	$1,133,000
Lauderdale	$119,000	$107,000	$4,000	$230,000
Lee	$32,000	$0	$0	$32,000
Madison	$362,000	$0	$14,000	$376,000
Mobile	$33,000	$0	$0	$33,000
Montgomery	$64,000	$0	$0	$64,000
Tuscaloosa	$117,000	$0	$0	$117,000
Total	**$1,362,000**	**$936,000**	**$32,000**	**$2,330,000**

Table 5.5-20 shows the HAZUS income losses related to relocation, capital, wages and rental income in the study area.

Table 5.5-20
Estimated Seismic Risk to Nine Most Populous Alabama Counties; Income Losses Related to Relocation, Capital, Wages, and Rental Income

County	Relocation	Capital	Wages	Rental Income	Total
Baldwin	$0	$4,000	$5,000	$5,000	$14,000
Houston	$0	$4,000	$7,000	$4,000	$15,000
Jefferson	$15,000	$228,000	$301,000	$245,000	$789,000
Lauderdale	$3,000	$40,000	$60,000	$44,000	$147,000
Lee	$1,000	$10,000	$13,000	$12,000	$36,000
Madison	$8,000	$125,000	$160,000	$133,000	$426,000
Mobile	$1,000	$12,000	$16,000	$14,000	$43,000
Montgomery	$2,000	$25,000	$35,000	$27,000	$89,000
Tuscaloosa	$3,000	$37,000	$50,000	$44,000	$134,000
Total	**$32,000**	**$485,000**	**$647,000**	**$527,000**	**$1,691,000**

Table 5.5-21 below shows the total estimated annual seismic risk for the Counties in the study area, and an estimate of seismic risk projected over a 30-year horizon, consistent with the calculations for other hazards in this section.

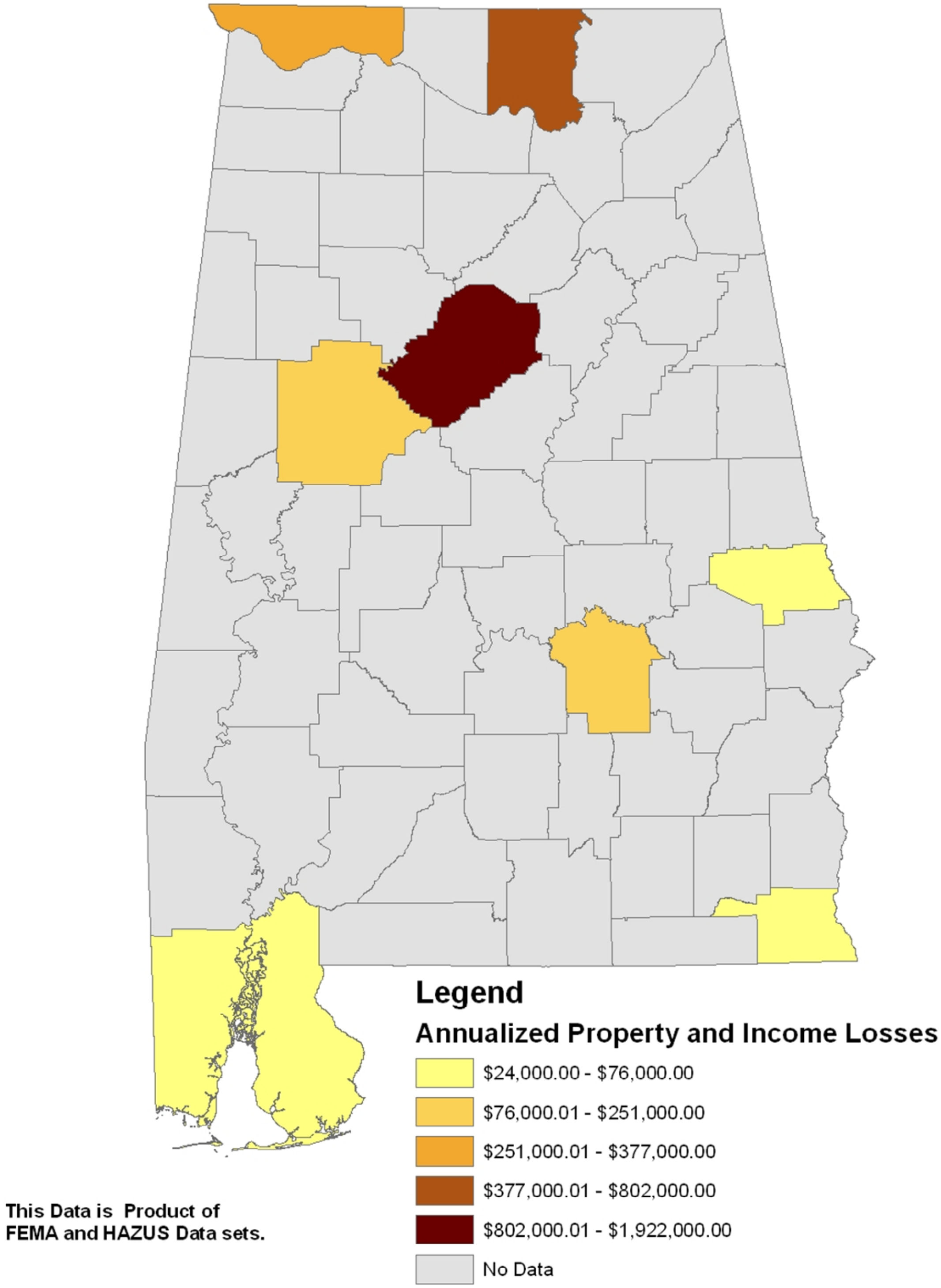
Table 5.5-21
Estimated Total Seismic Risk to Nine Most Populous Alabama Counties; with 30-year Risk Projection

County	Property	Income	Total	30-year Risk
Baldwin	$13,000	$14,000	$27,000	$335,073
Houston	$9,000	$15,000	$24,000	$297,843
Jefferson	$1,133,000	$789,000	$1,922,000	$23,852,020
Lauderdale	$230,000	$147,000	$377,000	$4,678,570
Lee	$32,000	$36,000	$68,000	$843,880
Madison	$376,000	$426,000	$802,000	$9,952,820
Mobile	$33,000	$43,000	$76,000	$943,160
Montgomery	$64,000	$89,000	$153,000	$1,898,730
Tuscaloosa	$117,000	$134,000	$251,000	$3,114,910
Total	**$2,330,000**	**$1,691,000**	**$4,021,000**	**$49,900,610**

Strengths, Biases and Limitations of the Methodology

This analysis uses FEMA's HAZUS software to calculate estimated seismic losses for a limited number of Counties across the State (the nine most populous). The utility of these results is limited by several factors. First, the shake and soils data is in the process of being updated. Estimates will be more accurate if the new data can be incorporated into the next iteration of HAZUS calculations (or via another methodology). Second, facility-specific HAZUS data is limited to the defaults in the software providing a fairly reliable initial estimate. However, more detailed information about buildings (structure type, use, size, occupancy, etc.), will facilitate a much more detailed and accurate calculation. As a secondary part of its long-term plan update and maintenance processes, the State will be undertaking detailed risk assessments for critical State facilities; this work will include data collection for seismic risk calculations. The calculations will be introduced into a future plan update.

Figure 5.5-21
Estimated Annual Seismic Risk (Property and Income) for the Nine Most Populous Counties in Alabama



Source: FEMA/HAZUS

5.5.4.3 Potential Dollar Losses to State Facilities in Seismic Hazard Areas

As noted elsewhere in this plan, at the time these risk assessments were performed there was no comprehensive inventory of State-owned and/or operated facilities that included sufficient data for a detailed risk assessment. Without facility-, population- and operation-specific information, it is not presently possible to estimate losses to State facilities with sufficient accuracy to make the estimates that would be useful in prioritizing mitigation activities. As noted in the previous sub-section, the State should initiate the data-gathering process with an inventory of its most important facilities; prioritize these by potential risk, then gather the data that would be required to perform a formal risk assessment. **Section 5.5.4** of this plan provides a brief additional assessment of this issue, and specific actions that the State is contemplating or already undertaking to address data insufficiencies.

Upon completion of this inventory, the State will be able to combine seismic risk maps to delineate which facilities are in the earthquake high hazard areas. The State will also conduct detailed risk assessment on a subset of these facilities based on the prioritization process. The result of this work will be incorporated into this risk assessment.

Of note is that the northern portions of the State clearly have more risk than the southern portions. This is due to these areas being located in closer proximity to the NMSZ, SASZ, and SCSZ (seismic zones described in **Section 5.2.6**).

5.5.5 General Summary and Recommendations

As anticipated, data for statewide risk determinations were mostly available for flood hazards, although information related to wind risk has improved markedly since the last version of the plan. A reasonable amount of information regarding past occurrences and dollar damages for tornado and hurricane hazards presently exists, but the data is insufficient for even a marginally accurate risk assessment for these kinds of events. Accurate risk assessments for any of the hazards require site- and facility-specific data, including information about both the hazards themselves, as well as the performance of physical and operational elements. The information presented in this plan should be used as the basis for the State to prioritize its mitigation actions in the immediate future, and to determine additional measures it should undertake to improve its ability to identify and address risks. The three sub-sections below describe data strengths and limitations for the most significant hazards in the State, and outline some potential steps that the State can initiate to address them.

In general, the flood risk assessment provides the expected results. As described in **Section 2**, risk is a function of probability, vulnerability and the value of community elements (including people) that may be impacted by floods. Notably, almost all flood risk is related to the built environment, and the expected result of defining risk in this way is that places with the most structures, infrastructure and people tend to have the most risk, particularly if the probability of flooding is high. Logically, in places where there are high probabilities of events occurring combined with relatively large populations and infrastructure, risk is the greatest.

As noted in the body of this section, because of their very high monetary value, casualties can dominate tornado and hurricane risk assessments. Although it is usually appropriate to include casualties in such an assessment, it is very important to recognize that risk is only one of many factors that must be considered in developing and prioritizing mitigation efforts. For example, although heavily populated areas have high risk from tornados (because there are many people), any assessment of a mitigation project would have to consider this information as well as contemplate the presence and effect of warning systems, the availability of shelter, and the ability of people to get to shelter in time to avoid a tornado. Similar considerations apply to all hazards and potential mitigation activities.

At the time the initial version of this plan was developed, Alabama had was working to create a sophisticated GIS-based data model to compile and analyze information about numerous assets, including county-, local- and State-owned and operated facilities. This will enable the State to assemble data about all of its facilities, and to perform detailed risk assessments. The most immediate actions will be to deploy AEMA staff to various assets statewide, to gather basic information about the facilities. This effort was delayed by the events of 2004 and 2005. AEMA is currently in the process of developing and prioritizing this inventory.

Additional long-term effort will be required to populate the GIS database with sufficient information to support risk assessments, but plans are in place to accomplish this, pending funding. Notably, the State has recently obtained DHS funding for a portal system, by which State and Federal agencies can share critical information from their respective GIS databases. AEMA, ALDOT, ADECA and the Office of Revenue have signed Memoranda of Understanding to facilitate access to other databases. The State is also presently working with the 9-1-1 system to share information in its databases. Although the success of the data population effort will be directly related to the funds available, AEMA projects that data on ten percent of the initial list of State-owned facilities will be entered into the GIS annually. This figure may be greater than that initially, assuming that the portal system described above proves effective – this may allow a significant amount of information into the system immediately. It is not anticipated that the information will provide a complete dataset to allow comprehensive and detailed risk assessments of all State-owned assets until later.

The most important action that the State can undertake at this point is to develop a comprehensive and reliable database of its facilities. Ultimately, this information is the basis of formal detailed risk assessments for all hazards, which can in turn be used to update the State and local mitigation plans.
As noted in several places earlier in this section, as part of the 2007 plan update, the State is performing an inventory and prioritization of State-owned facilities as the first step in detailed risk assessments for a subset of the most critical facilities. The results of this work will be incorporated into this part of the plan when they are completed.

5.6 Jurisdictions Most Threatened and Vulnerable to Damage and Loss

IFR Subsection 201.4 (c) (2) (ii) requires that the State Hazard Mitigation Plan include description of hazard vulnerabilities "in terms of the jurisdictions most threatened by the identified hazards…" This part of the Plan addresses that requirement. **Section 5.5** of this plan is a risk assessment for the three most significant hazards in Alabama, as identified by the SHMT. The present section summarizes the results of the risk assessment and describes the jurisdictions that are most at risk from floods, high winds (hurricanes and tornados), and earthquakes. As noted elsewhere, throughout the plan the primary unit of consideration is the county, and this convention continues through this section.

5.6.1 Jurisdictions Most Vulnerable to Damage and Loss from Floods

The following four tables summarize the results from the State risk assessment for floods and describe the jurisdictions most at risk.

Table 5.6-1
Expected Future Flood Losses for the Seven Most At-Risk Counties in Alabama, Based on National Flood Insurance Program Records

Rank	County	Risk
1	Baldwin	$211,414,960
2	Mobile	$145,861,163
3	Jefferson	$8,961,206
4	Coffee	$6,427,285
5	Escambia	$3,008,517
6	Shelby	$2,677,384
7	Dale	$2,344,991

Table 5.6-2
Number of Repetitive Loss Properties, Based on National Flood Insurance Program Records for the Seven Most At-Risk Counties in Alabama

Rank	County	# Repetitive Loss Properties
1	Baldwin	2,164
2	Mobile	1,959
3	Jefferson	209
4	Shelby	85
5	Coffee	48
6	Escambia	37
7	Greene	23

Table 5.6-3
Population in 100-year Floodplain for the Seven Most At-Risk Counties in Alabama

Rank	County	Population in Floodplain
1	Mobile	49,550
2	Jefferson	46,579
3	Montgomery	39,028
4	Madison	30,190
5	Tuscaloosa	23,563
6	Baldwin	19,286
7	Morgan	15,748

Table 5.6-4
Potential Flood Damage to Critical Facilities for the Seven Most At-Risk Counties in Alabama

Rank	County	Risk
1	Jefferson	$16,522,270
2	Mobile	$10,323,829
3	Madison	$6,482,578
4	Montgomery	$5,352,355
5	Tuscaloosa	$4,008,580
6	Baldwin	$3,786,485
7	Shelby	$3,433,103

As noted in **Section 5.5** there are important differences in the source data and calculation methods that have a large influence on risk, i.e. the dollar amount of future damages. The most significant outcome of these calculations and tables is the repeated high rankings of certain counties in the calculations, not the specific dollar amounts of future risk.

5.6.2 Jurisdictions Most Vulnerable to Damage and Loss from High Winds

It is important to note that tornado wind risk is not the same as probability. Risk is the result of probability, severity, vulnerability, and value (see **Section 5.4**). The probability and severity of tornados is fairly well established and likely to remain constant. **Table 5.6-5** summarizes the results from the State risk assessment for tornados (including both physical damages and casualties) and describes the jurisdictions most at risk.

Table 5.6-5
Potential Tornado Damage for the Seven Most At-Risk Counties in Alabama

County	Risk	Rank
Madison	$129,378,461	1
Jefferson	$105,329,321	2
Tuscaloosa	$24,848,144	3
Walker	$17,752,505	4
Cullman	$17,420,538	5
Shelby	$12,987,397	6
Dale	$11,394,485	7

As with the other hazards in this section, it is important to note that hurricane wind risk is not the same as probability. Risk is the result of probability, severity, vulnerability and value (see **Section 5.4**). The probability and severity of hurricanes in Alabama is fairly well established and likely to remain constant, notwithstanding the potential effects of global warming on weather patterns. However, a significant part of Alabama's population is located in the coastal areas of Mobile and Baldwin Counties, thus exposing many people and structures to the damaging effects of wind and water.

Table 5.6-6
Potential Hurricane Wind Damage for the Seven Most At-Risk Counties in Alabama

County	Risk	Rank
Mobile	$2,275,792,000	1
Baldwin	$1,212,623,000	2
Jefferson	$125,299,000	3
Montgomery	$99,557,000	4
Houston	$90,554,000	5
Blount	$81,835,000	6
Escambia	$65,007,000	7

5.6.3 Jurisdictions Most Vulnerable to Damage and Loss from Earthquakes

Although earthquakes are fairly common in Alabama, severe earthquakes are relatively unlikely, which explains the relatively small risk figures shown in **Table 5.6-7** below. All nine of the most populous Counties in the State are shown in this table, although in **Subsection 5.6.5** the ranking is limited to the seven most at-risk, in order to maintain consistency with the other parts of this section.

Table 5.6-7
Seismic Risk of Nine Most Populous Counties in Alabama

County	Property	Income	Total	30-year Risk	Rank
Jefferson	$1,133,000	$789,000	$1,922,000	$23,852,020	1
Madison	$376,000	$426,000	$802,000	$9,952,820	2
Lauderdale	$230,000	$147,000	$377,000	$4,678,570	3
Tuscaloosa	$117,000	$134,000	$251,000	$3,114,910	4
Montgomery	$64,000	$89,000	$153,000	$1,898,730	5
Mobile	$33,000	$43,000	$76,000	$943,160	6
Lee	$32,000	$36,000	$68,000	$843,880	7
Baldwin	$13,000	$14,000	$27,000	$335,073	8
Houston	$9,000	$15,000	$24,000	$297,843	9
Total	**$2,330,000**	**$1,691,000**	**$4,021,000**	**$49,900,610**	

5.6.4 Jurisdictions Most Vulnerable to Damage and Loss from Three Most Significant Hazards Statewide

There are two methods by which the vulnerability to damage and loss can be compared statewide. The first of these is to add the calculated risks from the three hazards for each of the counties, and then simply rank them from most future risk to least. However, for the reasons discussed in **Section 5.5**, these figures can be somewhat misleading, particularly because of the disproportionate influence of deaths (primarily for the tornado hazard) have on the numerical outcome. For this reason, **Table 5.6-8** below provides a simple count of the number of appearances in the other tables above.

Table 5.6-8
Distribution of Appearances in Top Seven Ranking, all Hazards
(List Shows Only Counties with Three or More Appearances)

County	# of Occurrences in Rankings
Jefferson	7
Mobile	6
Baldwin	5
Shelby	4
Madison	4
Escambia	4
Montgomery	3

This ranking should be considered only a general indication of risk statewide. Not that the seismic risk tabulations include only the nine most populous counties in the State, so it is possible that Escambia or Shelby could have increased the number of times either was in the top seven tabulations. However, this is relatively unlikely due to the very prevalent correlation between population and risk.

As noted elsewhere in this plan, accurate risk assessments and information about the performance and costs of mitigation measures (including policy changes), are the primary bases of mitigation planning. In order to be truly accurate, risk assessments must be highly localized, often addressing a single asset or operation. Because of this, the State-level risk assessment should be considered only a guide that identifies where the most risk is at a county level. In many cases, local and regional mitigation plans will include risk assessments and potential mitigation projects that are not found in one of the Counties shown in **Table 5.6-8** immediately above. In all cases the State will determine mitigation priorities based on the best available data, regardless of its source.

5.7 Impacts of Development Trends on Vulnerability

Development trends, particularly population shifts and land use changes created by major economic development expansions and infrastructure improvements of statewide significance, are important considerations to effective mitigation planning. These trends must be continually monitored and analyzed to keep abreast of changing vulnerabilities of jurisdictions and the increasing exposure of growing populations, new buildings, and enlarged infrastructure to natural hazards. As growth and development patterns change over time, the risks to property damage and lives also change. This section examines the projected growth trends and other impacts of statewide significance that are expected to affect the location and extent of natural hazards vulnerability over time.

This plan fully recognizes that changes in development for jurisdictions in hazard prone areas are on-going issues that must be constantly monitored and addressed in the State and local planning processes. Changing development trends and the on-going growth and shift of population can increase levels of vulnerability. The potential impacts of these changes can have adverse impacts, such as those noted here:

- Increasing demands for developable land area to accommodate new growth can push new development to previously undeveloped flood plains;

- New population growth is often concentrated along economically desirable coastal areas that are at high risk of coastal flooding, hurricane surge, and wind damages.
- New development and associated parking, roads, and other impervious surfaces can increase urban runoff, exacerbating flooding hazards.
- New construction in previously rural areas can push the wildland-urban interface, increasing exposure to wildfires.
- New housing may be constructed inadequately to withstand the damaging wind threats of hurricanes and tornadoes.
- Increased population can stretch the demand for limited water resources in times of drought.
- On-going beach development and construction can increase risk of beach erosion.
- More development in widespread areas subject to sinkholes can increase the probability of property and infrastructure damages.

5.7.1 Population Growth Trends and the Impact on Vulnerability

Alabama growth changes have been modest over recent years. Census 2000 recorded a population of over 4 million residents in the state of Alabama. Overall, the State has experienced steady growth from 2000 to 2006. Over this six year period, Alabama experienced the largest change in population from 2005 to 2006; just over one percent. The total population grew just over three percent for the 2000 to 2006 time period as presented in **Table 5.7-1**.

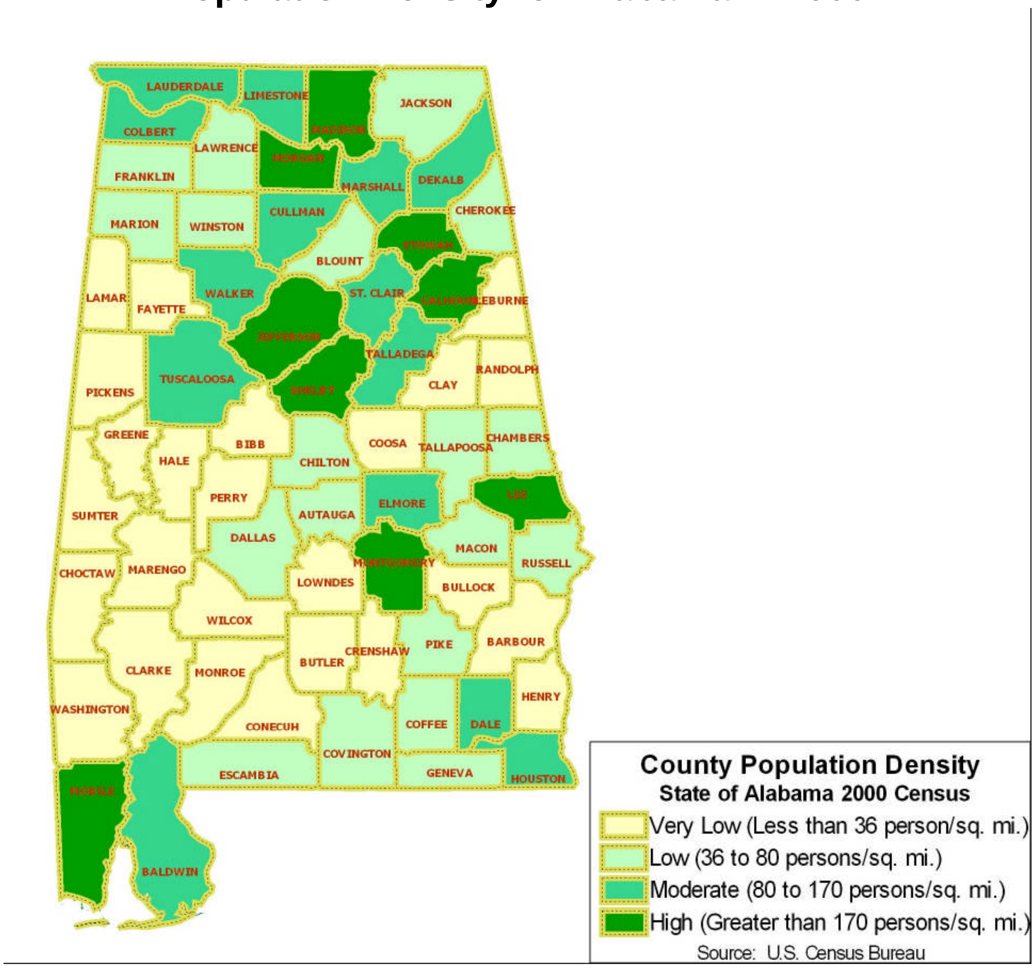
Table 5.7-1
Alabama's Population Growth from 2000-2006

Population		Population Gain	% Change
2000	2006		
4,447,100	4,599,030	151,930	3.4164

According to the 2000 Census and population estimates through 2006, Jefferson County is the most populous county in Alabama with over 650,000 residents and the most vulnerable to natural hazards occurrences (see **Table 5.6-8**). Mobile County is the second largest county with almost 400,000 residents and is the second most vulnerable county. The third most vulnerable county, Baldwin, was the state's fastest growing county between 2000 and 2006. Six of Alabama's fastest growing cites are located in Baldwin County: Orange Beach, Robertsdale, Foley, Fairhope, Gulf Shores, and Daphne.

Every county in the State is exposed to some risk of property damage or loss of life during a natural hazard. However, metropolitan areas such as Birmingham, Mobile, Huntsville, and Montgomery run a higher risk, because of population density and higher property values in metropolitan areas. Jefferson County features Alabama's densest population center as well as relatively high incidences of flooding, tornadoes, and severe thunderstorms (this is partly a reporting artifact). Mobile is similarly populated, but its coastal location means a higher incidence of tropical storms and hurricanes. It is important to monitor the plan regularly in order to track the types and properties at risk. Mitigation goals and strategies of this plan update have been reviewed and reprioritized based on the rate and amount of development that has occurred in high risk and highly vulnerable areas. **Figure 5.7-1** depicts the population density distributions of the urban and rural counties across the State. Five of the seven most vulnerable counties (see **Table 5.6-8**) are urban or urbanizing counties with relatively high population densities – Jefferson, Mobile, Shelby, Madison, and Montgomery counties.

Figure 5.7-1
Population Density for Alabama in 2000



Given the importance of population shifts over time, successful mitigation planning requires a look at future trends to assess future vulnerability. Population projections show that Alabama is expected to increase in size by approximately 21 percent by the year 2025. The population projections for the State and Counties are presented in **Table 5.7-2**. Much of this growth can be attributed to major manufacturers, such as Honda, Hyundai, and ThyssenKrupp Steel and Stainless USA, LLC. Each of these manufacturers has or should have significant growth impacts on the State as a whole.

It is important to reassess statewide vulnerability on a regular basis as growth in high hazard areas increases the overall types, numbers, and value of properties at risk. Much of the State's growth is projected to take place in the seven counties classified as the most vulnerable (see **Table 5.6-8**): Jefferson, Mobile, Baldwin, Shelby, Madison, Escambia, and Montgomery. Baldwin County's population is expected to grow by over 108,000 persons, a 76.9 percent increase from year 2000. Coastal weather dangers present a risk for Baldwin and Escambia Counties. Shelby County appeared four times in the ranking of counties most vulnerable to various natural disasters, and it is predicted to exhibit the largest gross population growth and percentage population growth in the State, thus increasing its vulnerability. The recent surge in manufacturing in southern Alabama will likely result in population growth greater than was estimated when these projections were first calculated.

Table 5.7-2
Alabama County 2000 Population and Future Population Projections

County	Census 2000	Projections					Change 2000-2025	
		2005	2010	2015	2020	2025	Number	Percent
Autauga	43,671	48,597	53,469	58,273	63,217	68,368	24,697	56.6%
Baldwin	140,415	162,314	184,375	206,251	227,727	248,436	108,021	76.9%
Barbour	29,038	30,482	31,871	33,156	34,290	35,246	6,208	21.4%
Bibb	20,826	22,805	24,861	26,910	28,889	30,749	9,923	47.6%
Blount	51,024	57,326	63,715	70,005	76,031	81,713	30,689	60.1%
Bullock	11,714	11,924	12,145	12,343	12,498	12,578	864	7.4%
Butler	21,399	21,052	20,806	20,640	20,543	20,447	-952	-4.4%
Calhoun	112,249	112,044	112,184	112,392	112,536	112,472	223	0.2%
Chambers	36,583	36,390	36,355	36,404	36,477	36,532	-51	-0.1%
Cherokee	23,988	26,166	28,320	30,407	32,384	34,220	10,232	42.7%
Chilton	39,593	43,455	47,398	51,347	55,242	59,022	19,429	49.1%
Choctaw	15,922	15,865	15,813	15,755	15,672	15,568	-354	-2.2%
Clarke	27,867	28,142	28,450	28,759	29,052	29,365	1,498	5.4%
Clay	14,254	14,773	15,277	15,738	16,160	16,553	2,299	16.1%
Cleburne	14,123	14,769	15,409	15,983	16,487	16,920	2,797	19.8%
Coffee	43,615	45,103	46,526	47,860	49,112	50,303	6,688	15.3%
Colbert	54,984	56,241	57,311	58,208	58,934	59,484	4,500	8.2%
Conecuh	14,089	14,096	14,133	14,155	14,148	14,101	12	0.1%
Coosa	12,202	12,697	13,127	13,478	13,727	13,875	1,673	13.7%
Covington	37,631	37,943	38,150	38,262	38,315	38,294	663	1.8%
Crenshaw	13,665	13,676	13,710	13,738	13,738	13,714	49	0.4%
Cullman	77,483	82,338	86,982	91,341	95,358	98,897	21,414	27.6%
Dale	49,129	49,818	50,561	51,324	52,095	52,820	3,691	7.5%
Dallas	46,365	45,605	45,111	44,823	44,699	44,648	-1,717	-3.7%
DeKalb	64,452	69,850	75,408	80,919	86,253	91,301	26,849	41.7%
Elmore	65,874	73,895	81,959	89,940	97,715	105,245	39,371	59.8%
Escambia	38,440	39,524	40,502	41,371	42,100	42,660	4,220	11.0%
Etowah	103,459	104,765	105,907	106,945	107,844	108,578	5,119	4.9%
Fayette	18,495	18,671	18,795	18,848	18,837	18,752	257	1.4%
Franklin	31,223	32,895	34,513	36,019	37,357	38,469	7,246	23.2%
Geneva	25,764	26,651	27,411	28,009	28,496	28,836	3,072	11.9%
Greene	9,974	9,807	9,688	9,572	9,439	9,311	-663	-6.6%
Hale	17,185	18,048	18,892	19,726	20,503	21,215	4,030	23.5%
Henry	16,310	16,662	16,977	17,218	17,373	17,428	1,118	6.9%

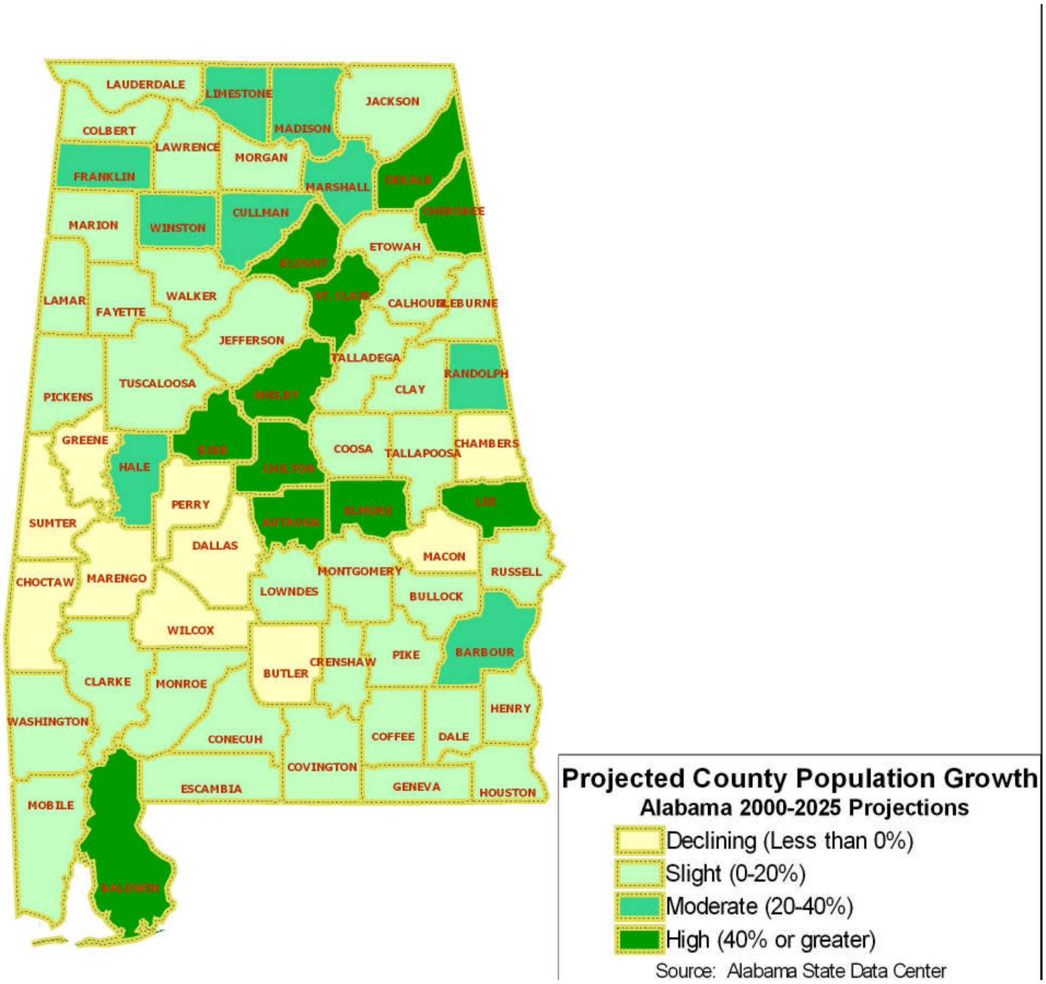
Table 5.7-2
Alabama County 2000 Population and Future Population Projections

County	Census 2000	Projections					Change 2000-2025	
		2005	2010	2015	2020	2025	Number	Percent
Houston	88,787	91,685	94,214	96,409	98,293	99,832	11,045	12.4%
Jackson	53,926	56,648	59,104	61,249	63,052	64,516	10,590	19.6%
Jefferson	662,047	667,018	673,771	682,336	692,065	701,651	39,604	6.0%
Lamar	15,904	16,019	16,105	16,158	16,179	16,175	271	1.7%
Lauderdale	87,966	91,636	94,983	98,015	100,749	103,176	15,210	17.3%
Lawrence	34,803	36,174	37,378	38,347	39,096	39,664	4,861	14.0%
Lee	115,092	128,075	141,303	154,474	167,261	179,495	64,403	56.0%
Limestone	65,676	71,237	76,638	81,747	86,505	90,865	25,189	38.4%
Lowndes	13,473	13,782	14,065	14,318	14,542	14,708	1,235	9.2%
Macon	24,105	23,708	23,389	23,095	22,804	22,505	-1,600	-6.6%
Madison	276,700	293,783	309,616	324,153	337,471	349,713	73,013	26.4%
Marengo	22,539	22,151	21,800	21,442	21,120	20,848	-1,691	-7.5%
Marion	31,214	31,809	32,283	32,593	32,739	32,710	1,496	4.8%
Marshall	82,231	88,256	94,319	100,304	106,064	111,385	29,154	35.5%
Mobile	399,843	408,727	417,520	426,288	435,084	443,553	43,710	10.9%
Monroe	24,324	24,364	24,424	24,483	24,535	24,586	262	1.1%
Montgomery	223,510	230,212	237,378	244,849	252,348	259,679	36,169	16.2%
Morgan	111,064	115,944	120,367	124,358	127,957	131,112	20,048	18.1%
Perry	11,861	11,515	11,283	11,109	10,976	10,872	-989	-8.3%
Pickens	20,949	21,090	21,259	21,434	21,591	21,740	791	3.8%
Pike	29,605	30,718	31,857	32,967	34,020	34,967	5,362	18.1%
Randolph	22,380	23,604	24,819	26,000	27,139	28,232	5,852	26.1%
Russell	49,756	50,926	52,066	53,147	54,203	55,198	5,442	10.9%
St. Clair	64,742	72,334	80,009	87,614	95,007	102,121	37,379	57.7%
Shelby	143,293	167,021	191,474	216,308	241,030	265,083	121,790	85.0%
Sumter	14,798	14,247	13,855	13,538	13,273	13,051	-1,747	-11.8%
Talladega	80,321	83,110	85,524	87,518	89,027	90,021	9,700	12.1%
Tallapoosa	41,475	42,428	43,259	43,891	44,318	44,567	3,092	7.5%
Tuscaloosa	164,875	170,259	175,547	180,779	185,813	190,524	25,649	15.6%
Walker	70,713	71,953	72,891	73,529	73,894	73,970	3,257	4.6%
Washington	18,097	18,655	19,139	19,524	19,854	20,123	2,026	11.2%
Wilcox	13,183	13,023	12,981	12,984	12,995	13,021	-162	-1.2%
Winston	24,843	26,236	27,555	28,744	29,808	30,714	5,871	23.6%
Alabama	4,447,100	4,644,503	4,838,812	5,028,045	5,211,248	5,385,997	938,897	21.1%

Note: Projections in this series are based on trends between the 1990 and 2000 censuses.

Source: U.S. Census Bureau and Center for Business and Economic Research, The University of Alabama, August 2001.

Figure 5.7-2
Projected County Population Growth for 2000-2025



5.7.2 Economic Development and Transportation Improvement Impacts on Vulnerability

Alabama has recently experienced a surge in economic development activity. Honda Manufacturing of Alabama, LLC located in Talladega County, has contributed billions of dollars to Alabama's economy. Honda employs almost 5,000 Alabamians at its Lincoln, Alabama plant. Eighty six percent of these employees were from Calhoun, Etowah, Jefferson, St. Clair, and Talladega counties. Honda's 24 suppliers employ over 4,000 additional Alabamians. Employment with Honda is predicted to continue to increase.

In April 2002 Hyundai Motor Manufacturing Alabama, LLC announced plans to build an automobile assembly plant in Montgomery, Alabama. The plant began operating at full capacity in 2007, employing almost 3,000 people. The plant is located on 1,600 acres providing plenty of acreage for future expansion. Hyundai is responsible for bringing 30 parts suppliers to the area, which has helped lower the typically high unemployment rate in this part of Alabama known as the "Black Belt" (for its rich black soils). Each of the 30 suppliers is within a 90 mile radius of the plant. The Korean based company is a $1 billion investment in Alabama's economy.

On May 11, 2007, ThyssenKrupp Steel and Stainless USA, LLC announced that Calvert, Alabama had been selected as the site for a new steel plant, a $3.7 billion investment. Construction is expected to begin in 2007 with operations beginning in March 2010. The plant is expected to encompass over 3,500 acres of land in north Mobile and south Washington Counties. ThyssenKrupp will provide nearly 3,000 Alabamians with permanent jobs. The Alabama Port Authority is in the development stages of the Pinto Island Terminal, which will serve as an import/export terminal for ThyssenKrupp.

South and Central Alabama will experience the greatest amount of development and land use change in the State due to the ThyssenKrupp plant in Mobile, the Hyundai Plant in Montgomery, and the Kia plant located in nearby West Point Georgia. Lee, Lowndes, Tallapoosa, and Macon County's geographic location makes them prime sites for Kia and Hyundai suppliers. Autauga and Elmore counties have plans for substantial residential developments. An increase in housing is anticipated in southwest Montgomery for employees of Hyundai and its suppliers. A new research park opened in Auburn in 2006. The City of Auburn, in Lee County, is expected to continue growing in years to come, especially in northwest, west, and south parts of the city. This area is also expected to receive residents from the Fort Benning BRAC Realignment in nearby Columbus, Georgia. Tallapoosa County is experiencing rapid growth along Lake Logan Martin. Growth along the Lake is expected to continue into the future. BRAC realignments in Huntsville at Redstone Arsenal, and Fort Rucker in Dothan will likely have a significant impact on development trends in Madison and Houston Counties respectively. These increases in growth and development potentially increase risk and vulnerability to hazards and loss of life and property.

Significant transportation improvements will affect development trends throughout the State. The most significant projects include the I-85 extension from Montgomery to the Mississippi Line, Highway 83 expansion to link Foley Beach Expressway to Interstate 10 (I-10), Corridor X / I-22 link between Birmingham and Memphis, US 280 improvements east of Birmingham Foley Beach Expressway expansion to five lanes for hurricane evacuation, the expansion of I-10, and the widening of US 80. All of these major infrastructure improvements affect land use and development demands, which in turn change vulnerability.

The State will continue to monitor these development trends and adjust its mitigation responses accordingly. This plan update reflects the changes in population and growth patterns since the 2004 plan, and future updates will address continuing changes over time.